Metals and Alloys

THE ENGINEERING MAGAZINE OF THE METAL INDUSTRIES

PRODUCTION • FABRICATION • TREATMENT • APPLICATION

DECEMBER 1942

A SMALL FURNACE WITH BIG QUESTIONS

- ★ What type of refractory should be used?
- ★ What effect will slag have upon the refractory lining?
- ★ How can the refractory be protected against erosion?
- ★ How can the load-carrying ability of the floor brick be judged?
- ★ What will be the heat losses due to periodic operation?
- ★ What is the best type of arch or roof support for this furnace?
- ★ What precautions should be taken against the effects of expansion and contraction?
- ★ Will heat losses through the structural steel be great? How can they be minimized?
- ★ Should the brick be laid with a heat-setting or an air-setting mortar?
- ★ What type of wall anchoring, if any, is most suitable?
- ★ What protection, if any, should be provided against flame impingement?

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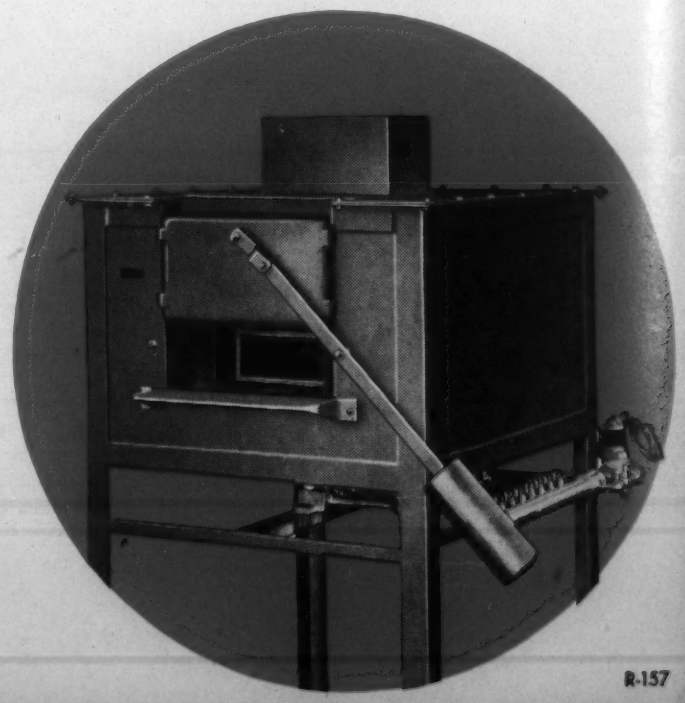
B&W Refractories Engineers are qualified to give advice on furnaces like the one illustrated, or on stress-relieving units that employ as many as 80,000 B&W Insulating Firebrick. Their advice is free and without obligation.



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Metals and Alloys

THE ENGINEERING MAGAZINE OF THE METAL INDUSTRIES

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HOLDEN *Announces*

24 pages of NEW ENGINEERING DATA

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Contents

This new publication contains a complete list of Holden Heat Treating Baths and their applications together with a detailed description of Holden Pot Furnaces and blueprints of piping and wiring layouts.

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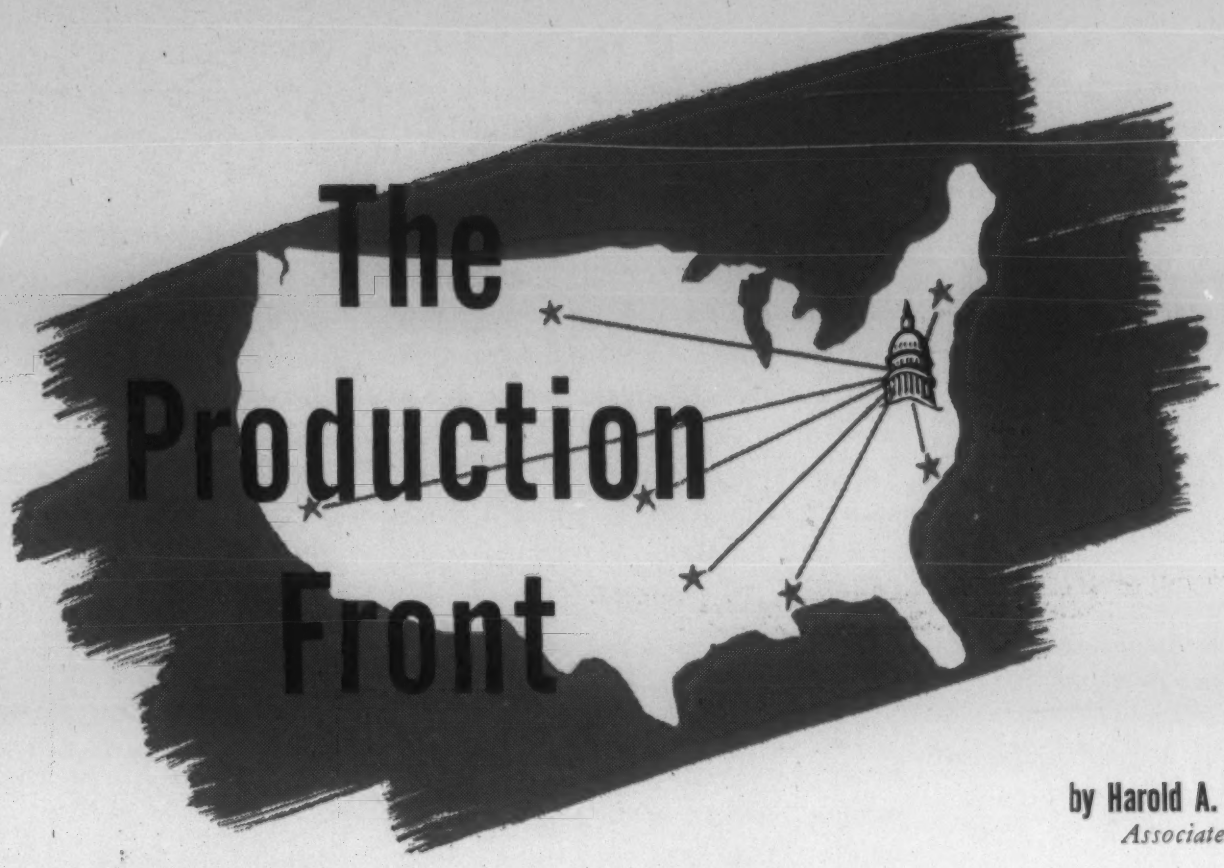


by Harold A. Knight
Associate Editor

We're in era of "end of beginning." . . . Alloy steel and copper limit 1943 war production. . . . World crisis in zinc. . . . Echoes from the zinc tariff reduction. . . . 100 per cent conversion from brass to steel cartridge cases. . . . Brass mill capacity a bottleneck. . . . Black plate scarcer than tin. . . . More attention to essential civilian needs.

How to get rubber coating off copper wire. . . . Non-ferrous scrap not as critical as ferrous. . . . 4000 miners furloughed from Army. . . . Voluntary manpower conversion 10 per cent effective. . . . Artistic temperaments win production prizes. . . . 91 per cent orders for war materials.

Behind the scenes of CMP. . . . What! Metals a substitute for wood? . . . Tank-Automotive headquarters rightfully moved to Detroit. . . . One gesture, finally, towards simplification of Washington hodge-podge. . . . Conversion makes for versatility. . . . No censorship for Rommel. . . . Let's standardize alloy scrap collection.

Strategy and Tactics

One can trace the progress of the war efforts of the United Nations through the epigrammatic statements of Winston Churchill. Apparently we have left the "too little and too late" era and have attained the "end of the beginning" but cannot yet set a date for the "beginning of the end."

Inasmuch as "Winnie's" classic remarks apply to military operations in the field, and since the production front theoretically moves perforce some three or four months ahead of the fighting front, P. F. may have passed beyond the "end of the beginning" stage.

"Alloy steel and copper will limit production in 1943," one of the genuine leaders in Washington told us not long ago. The new Controlled Materials Plan will pivot around this truth. "I am much more encouraged about the materials situation than I was three months ago," this leader continued. In the next breath he made a startling statement — "The world position in zinc in 1944 to 1945, or earlier, will be very serious, particularly in this country, since the known reserves of zinc are on the point of exhaustion."

Zinc Warnings Heard in 1938

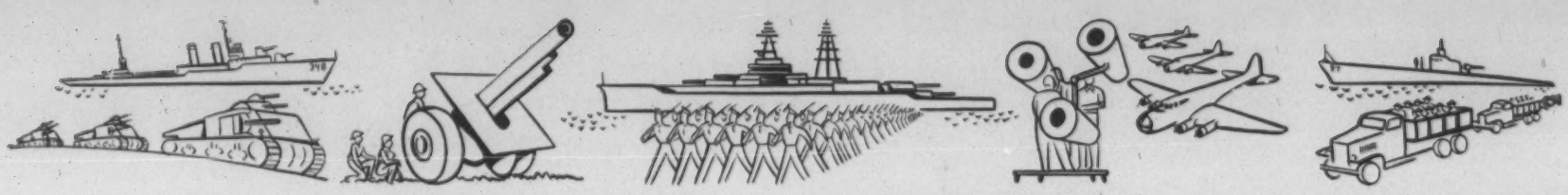
This zinc statement recalled to us the forebodings expressed by American zinc producers in late 1938 when the Government was about to lower the zinc duty towards favored nations by 20 per cent. They warned that zinc prices would have to be cut 20 per cent also, and that this would remove the incentive to search for new zinc deposits, The new tariff took effect January 1st, 1939, and the cut in zinc price followed according to prediction.

Yet the use of steel cartridge cases in place of brass will relieve zinc markedly. We have the official statement that before January 1st more than 40 firms will be in production of steel cases, making 100 per cent the changeover from brass to steel cases in all calibres of fixed cannon ammunition. Ordnance Chief Campbell pointed out that a great factor in speeding this conversion has been the perfection "almost overnight" of a cold-draw process that turns out cases in a matter of moments. He described this job as "amazing."

The critical nature of copper is a long-range proposition, whereas at certain times a plethora of red metal appears. Thus, at mid-November lack of brass mill capacity was a bottleneck rather than the copper supply, but with a planned expansion by 30 per cent in brass melting capacity, this promised to be rectified shortly. One reason for the apparent long-range scarcity is the need to pile up ammunition in several points of the globe for any emergency. Possibly Dutch Harbor, in Alaska, has ten times more ammunition stores than will ever be used.

Black Plate Scarcer Than Tin

We are told that the tin problem has been so thoroughly licked that the black plate supply is more critical than the tin which coats it for cans. We can get along on 15,000 tons of tin yearly.



One of the newer lines of thought at Washington is that essential civilian needs must not be neglected since, if a nation's economy breaks, the military efforts crack also. The British have already honored this concept and Germany may have realized it too late. Hitler neglected his railroads, emphasizing his motor highways, veritable masterpieces of engineering and art. The trouble is, he doesn't have the gasoline to operate on them.

Our secondary raw materials — scrap — are giving a good account of themselves, the public's drive passing all expectations. Plenty of problems still remain, such as labor supply for sorting and cutting the scrap on the civic junk piles and transportation for conveying it to the mills. But, despite squabbles between New York's fiery "Little Flower" and WPB over responsibility, the scrap is in sight and will keep the mills operating for several months to come.

Rubber Coated Copper Wire

An interesting minor headache centers around rubber-coated copper telephone wires connecting homes and street lines. How to salvage both rubber and copper economically has proved a snag (yes, literally, too, because of kinks in the wires).

There are cracking rolls, which take off the rubber, and in some processes pulverize it so it passes through a 10-mesh screen. Yet what have the salvagers got? The rubber is only fifth grade. It contains 20 per cent moisture, is contaminated with copper sulphate and one third of the covering is a treated textile fabric. Reminds us of the old formula for cooking German carp: Place on hemlock bark; boil, parboil, fry, steam, broil, bake. Then throw away the carp and eat the bark.

The need for ferrous metal scrap is much more urgent than for non-ferrous, all are agreed. For one thing, non-ferrous is the more profitable for the dealer to handle, and many have switched from ferrous to non-ferrous, making the former under-manned. Large quantities of scrap are already coming back to this country from our battlefields.

For another month, apparently, manpower is the greater shortage than raw materials. WPB's figures as to "lost production" in the mines due to lack of manpower in August are: Copper and magnesium, 30 per cent each; molybdenum, 25 per cent; fluorspar and tungsten, 20 per cent; zinc and lead, 10 per cent.

Four Thousand Miners Furloughed

Yet since then the situation has been partly rectified. In the Idaho mining districts, 4000 former miners in the Army have received a 90-day furlough to work in the mines, and the furlough may be extended. There has been decided improvement in key mining districts, such as Montana and Arizona, since the above figures were issued.

Many industrial plants have by now prepared their "Manning tables," which give an inventory of manpower. Not only do they list all skills, but they give data on what number of men can be replaced with virtually no training; what number with three months, six months, etc.

Paul V. McNutt told us that compulsion must step in to transfer men and women from non-essential to essential industries. Mere persuasion has so far been only 10 per cent effective. Moreover, the Government's policy will be to move work to where labor supply is. More industries will be given the same orders received by gold mining — to cease and desist operations.

Rabbis and Musicians Invent

Our man-power in war-time is proving versatile. At least 10 per cent of those receiving Certificates of Individual Production Merit by WPB were in pursuits far afield from mechanics, invention and war production before the war. Thus, Herbert Rupert James, National Tube Co., McKeesport, Pa., was an organist, pianist, teacher and conductor of both orchestral and choral music before the war. In his new job, he rigged up a multiple acetylene torch arrangement for brazing tool tips to tool shanks that greatly increases the quality of the product, which is sweet music for the management.

Samuel Mayer Feiner exemplifies the spirit of "Praise the Lord and Pass the Ammunition." He came to this country 20 years ago to serve as a rabbi in Chicago. While at Bethlehem Steel Co.'s Shipbuilding Div., San Francisco, he designed four gages for a hand-operated elbow-edging machine, which are saving over 1,000 man-hours monthly.

Statistics and Smiles

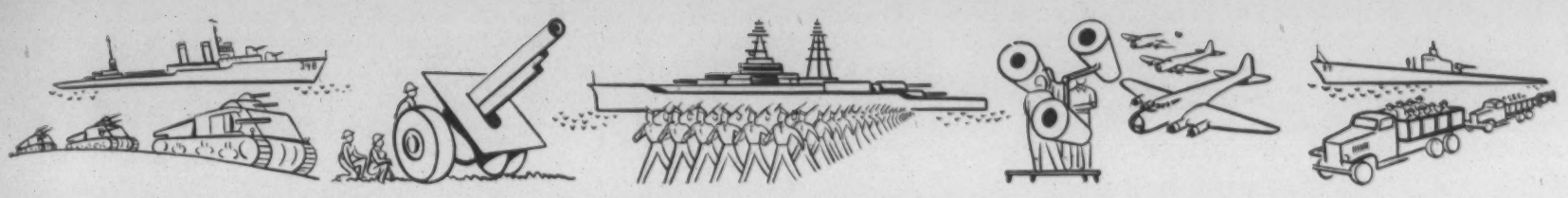
Discussions on production are never complete without a few statistics. Of all the orders in 3021 metal plants at the end of July, 91 per cent were devoted to war materials. After a long period of suppression, pig iron production figures were issued by the American Iron and Steel Institute. The estimate for 1942 is 60,500,000 tons against 55,100,000 tons in 1941 and 44,167,000 tons in 1916, the peak of the first war. It is estimated that 1,500,000 tons of aluminum, including 300,000 tons of secondary, will be available for consumption in 1943.

The smile of the month was given us by that red-blooded periodical, *The Scrapper*. Under the title-piece appears: "Publication and Distribution Approved in *Principle* [Italics, ours] by WPB." Someday we will get up the nerve to ask our boss if he can say as much about us.

Many Ingredients in CMP

In general, the Controlled Materials Plan is but little like the original one submitted by the automotive industry and is only distantly related to the British plan that has been operated successfully.

It is a pot-pourri of numerous suggestions, and has been jelled to its present consistency only after a series of mental slugging matches in which four schools of thought turned Washington into a vociferous debating society as to which ingredients should go into the pot. The handful of industry-trained WPB officials who knew



most about it were, at times, ganged up against by the professional planners.

In Washington, Robert R. Nathan, WPB's Planning Committee chairman, emerged as master chef. Acting head chef is Mr. Eberstadt, WPB's vice chairman on Program Determination. His aide is Ernest Kanzler, the only member of the top galaxy who has worked at producing anything in mass, but whose career is that of a banker and financier. Appearing like an afterthought, J. A. Krug, with a brand new title of Deputy Director General for Distribution, and a newcomer, Harold Boeschenstein, president of Owens-Corning Fiberglas Corp., entered the picture as expeditors. Just what their part will be will depend upon "processing" of a mass paperwork. Neither knew quite clearly enough to explain their mission to METALS AND ALLOYS.

In industry, the reaction is mixed on the less-than-enthusiastic side. Industry's sad and time-consuming experience with PRP, which is being prepared for formal burial, dampens any high hope. There has been an undercurrent battle between the interests of the munitions factories and the materials suppliers, and many industrialists believe that this was the best that could come of any battle of amateurs-in-the-saddle. Technology has no authority in Washington — neither "high command" as the President once asked for, nor "low," as dreamed of by those who know enough about production engineering to talk sense.

Metals Merely a Wood Substitute?

We are not telling anybody anything when we say there will be a merry competition among materials after the war. And along comes Nathaniel Dyke, Jr., technical consultant to the Lumber and Lumber Products Div., WPB, stating that "steel, iron, aluminum, magnesium and other metals will have to start over again to prove they are a superior substitute for wood. The latter will be termite proofed, water proofed, urea treated and cooperage will be treated or coated separately for different uses."

Industrial Salvage and That Nail and the Kingdom

Back in ye ancient tymes a kingdom was lost — all because of a defective horseshoe nail that apparently had been incorrectly heat-treated. Because of this nail, the shoe, the rider, the battle, and the kingdom were lost — remember?

By the same token the cause of the United Nations could be lost. Ferrous materials are basic. Production of iron ore and pig iron are virtually static. The variable is scrap, where the most increase is possible.

The public has already given its all. The remaining "out" is dormant industrial scrap. E. W. Greb, Industrial Salvage Branch, WPB, an inspiring crusader, told us that such scrap collection is a long-range prospect. Any machine, idle three months and promising to be idle another three, is automatically earmarked for scrap. Mr. Greb counts on a continuous supply on this cycle.

Here is where *we* enter! Just as the popular newspapers sponsored the public's scrap drive — so are the technical and trade press asked to sponsor industrial scrap. The campaign was launched December 7th. You'll be hearing more anon.

Then, of course, wood is inexhaustible, for nature keeps replenishing the supply, contrary to the case with metals. Mr. Dyke promises that in the future there will be no waste from wood because of "new processes of getting alcohol by dissolution instead of distillation, the manufacture of sugar, vanillin hog feed and other surprising developments. There will be no sawdust pile at the mill, no burner consuming millions of dollars of value. The whole tree will be used." Can't somebody find some way of extracting alcohol and sugar from metals?

Aircraft Comes Down to Earth

The WPB Aircraft Branch has emerged as the Aircraft Production Committee under the most able aircraft production authority in Washington, T. P. Wright, a former vice-president of Curtiss-Wright. He and his staff of 200 have moved to the Pentagon Building.

This is splendid news for aircraft, engine, propeller and accessory manufacturers, although one WPB masterminder wailed, "They can't do that to us. We're supposed to control aircraft production."

Detroit for Action

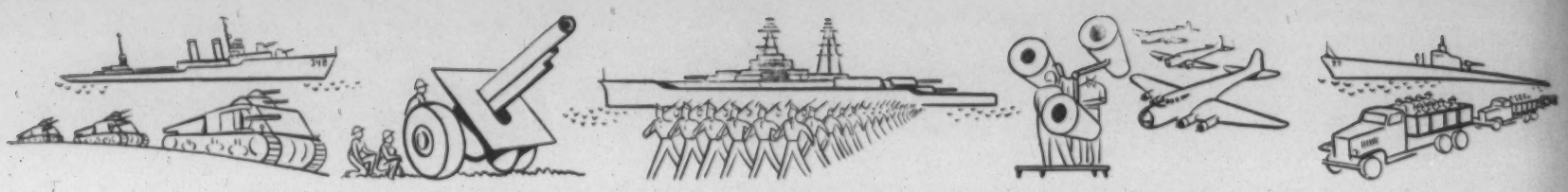
Although it just moved in, the Tank-Automotive Center in Detroit is doing far more per day in winning the war than it could have done in Washington. Weapons have become mobile to such an extent that the automotive industry appears to have a finger in every known armament item.

Army and civilian engineers are now where they belong, and long-headed Maj.-Gen. Levin H. Campbell, Jr., Chief of Ordnance, has given industry just what it needed — closer contact in design, testing, manufacturing, and maintenance of weapons. Under Brig.-Gen. A. R. Glancy, formerly president of General Motor's Pontiac Division, Army's Brig.-Gen. Donald Armstrong and Brig.-Gen. John K. Christmas, an important armament speedup is in the offing.

Heaven To Have No Questionnaires

We should like to be able to compile convincing and authoritative statistics to prove that more simplified questionnaires and blanks for the harassed manufacturer to fill out would save, say, 1,000,000 man-hours a month that could be devoted to actual production. All along we have believed that the Government has made paper work too complex, and, being on the fuel oil rationing board in our home town, think so more than ever.

In the early days of the war ef-



forts, steel makers told us that 85 per cent of the OPM reports mailed them by their customers were incorrectly made out. They finally sent their salesmen into the field to educate their customers.

Then, just when all understood the "PD's" and could turn them out p.d.q., they threw out the OPM and brought in WPB. As one steel maker plaintively told us, "They change the rules in the middle of the ball game. By last August we at last had all our customers reasonably satisfied as to supply. Then they changed the rules and all has been utter confusion since."

A No. 1 man in Washington told us recently that he believes PRP would have worked if they had been a little more patient with it and put into it a supplemental ruling or two. But by July 1st PRP will be thrown out the bay window completely and the new set-up, Controlled Materials Plan, substituted. The author of the latter spent a half hour explaining it to a group of us and we bombarded him with questions later. Our impression is that it sounds logical and, we hear, somewhat resembles what has been used in the automotive industry, but we wonder. It better be good!

But at last comes a favorable development. They are calling lawyer's verbiage and foolscap flourishes civilian and throwing it out for the duration. OPA Revised Maximum Price Regulation No. 195, issued in mid-November, has replaced legalistic phraseology with simple and clear language, aided by specific examples where they are necessary. This particular regulation applies to industrial wooden boxes. Evidently the ones who wrote this didn't have wooden heads.

Conversion Has Been Educational

How far afield industrialists have gone in their conversion from peace to war production would make an interesting chapter in a book on our war production. Perhaps the majority of manufacturers found a "natural" in their conversion.

Thus, as Arthur D. Little, Inc., Cambridge, Mass., points out, a manufacturer of centrifugals for making plastics now produces much the same centrifugals for smokeless powder plants. A maker of hosiery and sheer fabrics for underwear changed a few gears in his looms, making mosquito netting for the armed forces. A manufacturer of jewelry, already having skilled labor, needed only one small lathe to switch to surgical instruments.

"For many plants, however, war has brought profound changes in production techniques in materials and standards," continues Little. "Thus, a company that made nail polish now makes and assembles airplane communication systems; a linoleum and resilient tile concern makes bomb racks, rudders for shells and tank parts. Here not only were new machines and materials involved, but practically entire working forces had to be retrained. In the linoleum plant, classes were set up in riveting, welding, press work, heat treatment and blueprint reading.

"All this seems a good omen for post-war industry," concludes Little. "Thousands of concerns are learning how to hold the tolerances and meet the exacting standards demanded by war material. Millions are acquiring new skills and a first-hand knowledge of aluminum, magnesium, plywood, etc. almost sure to see wide service in consumer goods of the future."

Censorship and Rommel

Aren't we going too far in our censorship of technical information and statistics? When Rommel drove the British out of Tobruk and to within 60 miles of Alexandria, he barked orders in guttural (or shall we say "gutter") German over the radio for teammates and enemy alike to hear. The English meanwhile sent orders in code and considerable time was wasted in decoding the orders.

Same with broadcasting technical and trade information in this country. Will not the rapid dissemination of techniques along our own production front more than offset what may leak out to our enemies? Isn't the fact that we would be one step ahead of our enemies in this fast war all-important?

Standardizing Scrap Metal Emblems

Aircraft plants and others are distinguishing their scrap containers with distinctive colors so as to make segregation more foolproof. This is an idea that bids fair to take hold quite universally. Some bright engineer some time will develop a universal color system that may become standard.

Navy Ordnance has already issued a chart, brilliant with colors in the form of circles, as many as four colors per circle. The system starts out logically enough with one color representing a certain metal, but it breaks down as it progresses and becomes more complicated, that color being used eventually for other metals.

The ideal system, perhaps, will be using the same color consistently in the form of bands. Thus, in stainless steel the chromium band (with percentage 18) would be widest and in its distinctive color, with the nickel band (8 per cent) about one half as wide as the chromium and in its own color. The popular form of stainless steel would be plainly indicated.

Let some enterprising novelty or tag manufacturer make these standard labels and sell them to industry.

Again, how about a standard container for scrap — square, and so sized that, say, 16 units fill a flat car? Thus, standard and interchangeable, they could be shipped among plants and scrap dealers conveniently. This is somewhat along the line of less-than-carload lot shipments of merchandise generally, now in vogue.

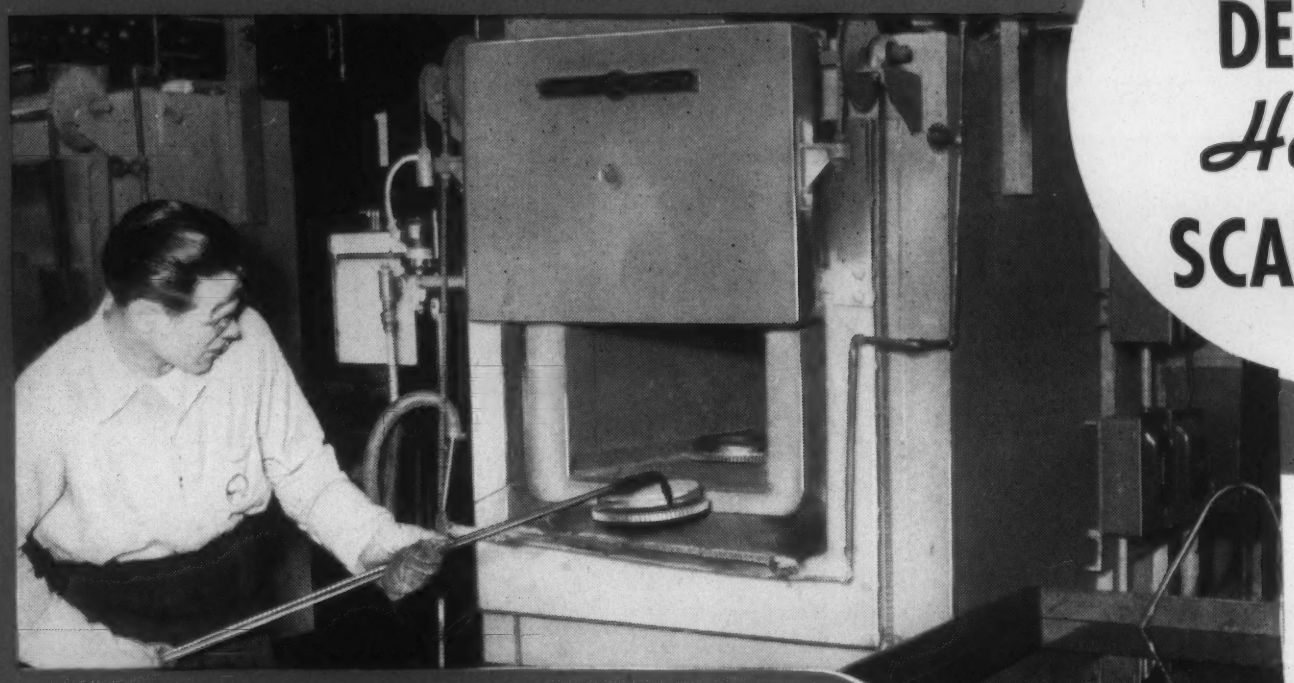
Alloy Steel Production

Alloy steel production in October was 60 per cent higher than the average month of 1941, H. G. Batcheller, director of WPB Steel Div., told the National Association of Manufacturers in early December. (We figure October, 1942 output as over 1,000,000 tons, therefore.)

ARE YOU LOSING TIME

CLEANING, MACHINING, and GRINDING?

Prevent **DECARB!** *Harden* **SCALE-FREE**



MANY TYPES of parts in various industries are now being heat-treated decarb-free by such installations as this one. Here gears are being treated in an engine plant.

Use a Standard G-E Box-type Furnace *with DRYCOLENE*

Where scale-free hardening without decarburization is required, where saving time is an important factor, where uniform hardening is demanded, G-E box-type furnaces with drycolene are doing the job.

Used with drycolene, an atmosphere gas that prevents decarburization of carbon and alloy steels, this type of furnace gives you work that is free of scale and decarburization. The parts come out clean. This eliminates costly cleaning and machining operations — saving valuable time.

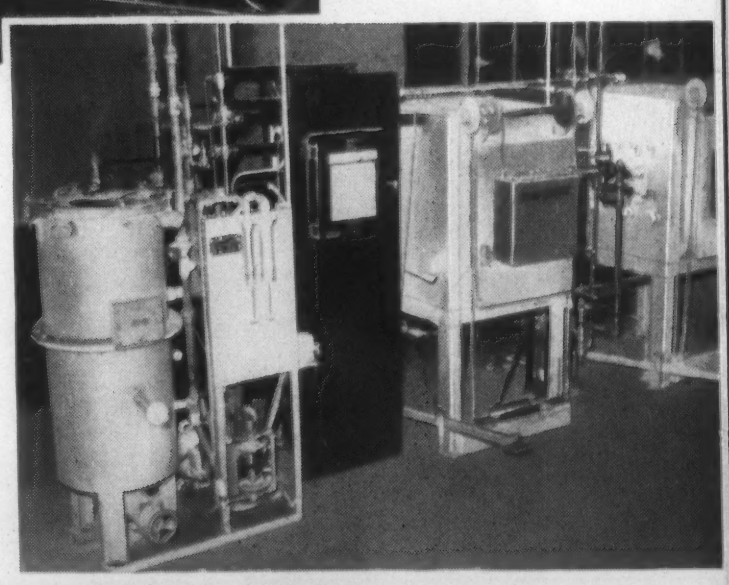
A high-velocity flame curtain projects upward across the furnace throat and guards against atmosphere losses. This prevents the entrance of air and loss of drycolene when the furnace door is opened.

A separate compensating circuit distributes the heat uniformly throughout the loading space, while another circuit automatically regulates the temperature. That's why the parts are uniformly heated.

Easy operation is another feature of these furnaces. The composition of drycolene and its flow into the furnace are maintained automatically. No attention is required by the operator. Maintenance is low.

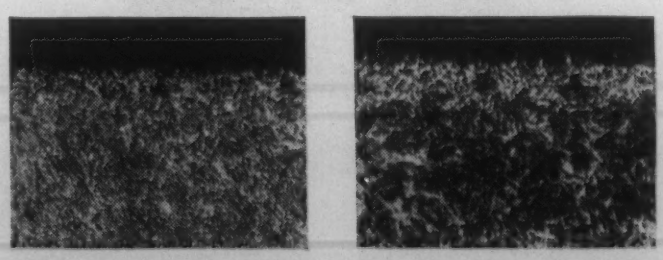
Although designed primarily for use with drycolene, this line of furnaces can also be used with other types of atmosphere gases.

Whenever you have a heat-treating problem, get in touch with the nearest G-E office. Our engineers will make a study of it, and recommend the right furnace for the job, selected from dozens of tested and proved G-E heat-treating equipments that are available. *General Electric Co., Schenectady, N. Y.*

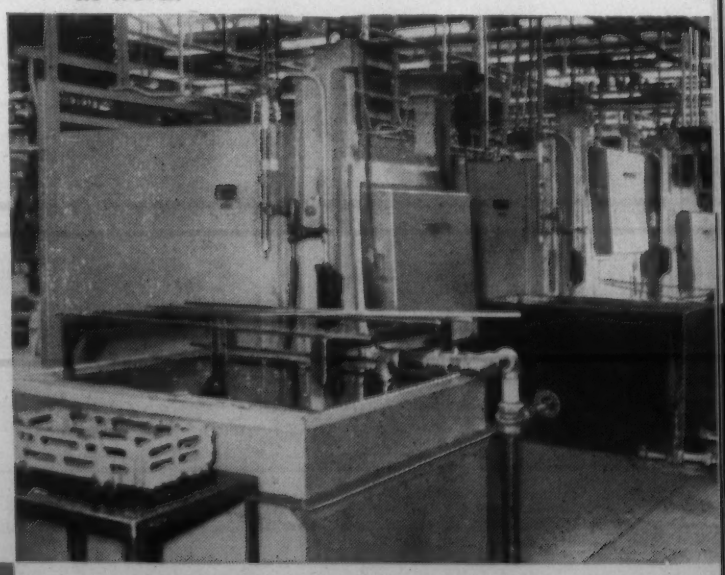


UNIFORMLY HARDENED parts are assured by heat-treating in G-E box-type furnaces with drycolene. Here are a preheat furnace and a high-speed furnace and a drycolene producer at work.

HERE'S THE PROOF



Compare these photos. **Left** shows SAE 52100 after 2 hours, 1500 F, in furnace using drycolene as protective atmosphere. Absolute uniformity of structure extending to surface is proof of no decarburization. **Right** shows same steel after 2 hours, 1500 F, in furnace using partially converted gas as protective atmosphere. White band at the surface indicates carbon-free ferrite and is proof of decarburization.



THIS METHOD of decarb-free hardening has proved so satisfactory that many manufacturers have installed several of these furnaces with drycolene producers.

The Navy "E", for Excellence, has been awarded to 92,780 General Electric employees in five plants manufacturing naval equipment

GENERAL ELECTRIC

FERRO-CARBON TITANIUM IN STEEL

promotes thick-skinned ingots that improve yield of HOT ROLLED SLABS

Throughout the present national emergency, increased emphasis is placed on producing more and more good steel. TAM Ferro-Carbon Titanium, used as the final deoxidizer in the ladle, cleans and purifies steel promoting thick-skinned ingots that roll with few cracks thus improving the yield of hot rolled slabs. A TAM Metallurgical Engineer will gladly submit data on the benefits of Titanium in steel. Write:

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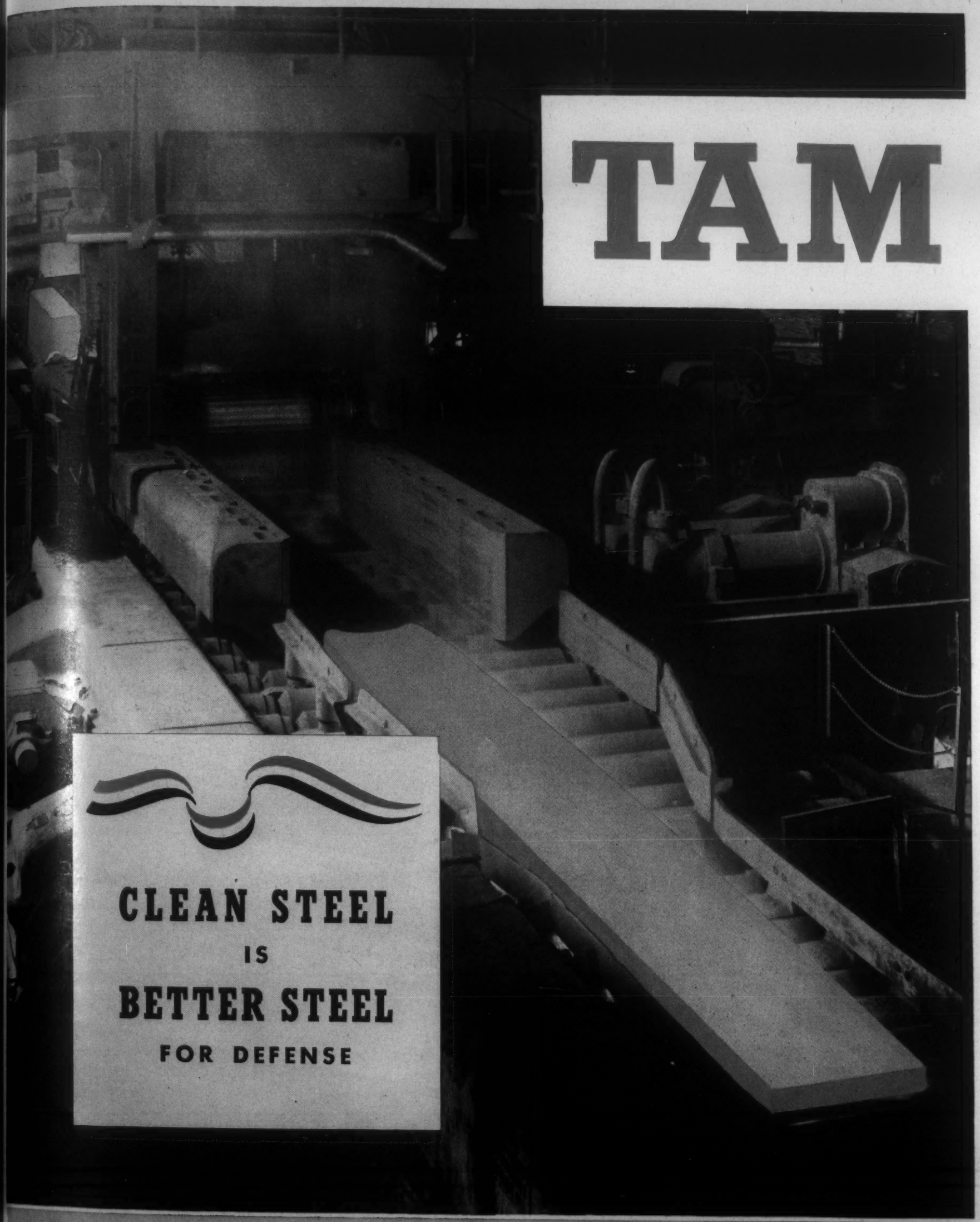

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How Tool Shapes can cause hardening hazards

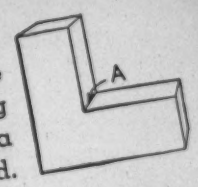
In designing a tool many things require consideration. The following suggestions are concerned only with tool design as it affects the heat treating operation—and through the heat treatment, the serviceability of the tool. They are based on experience, and are given to help bring about a better mutual understanding between the designer and the steel treater, so that designs which may cause cracking or distorting during heat treating can be avoided.

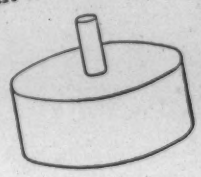
Heat treated steel has a certain strength depending upon the analysis of the steel, the quality of the metal, and the heat treatment which it has received. Sometimes just the internal strains set up in heat treating exceed the strength of the metal, and the tool cracks before it ever sees service. Or, if you get the tool through the hardening process safely, it may be so weakened that it will fail in service under relatively light loads.

Internal strains arise from many causes, but the most serious are those developed during quenching, by reason of differential cooling of sections of the tool that are of markedly different size or mass. Thus, the differential cooling that causes internal stresses is largely controlled by the size and shape of the piece being quenched. In other words, its design.

It is desirable where possible to plan shapes so that the entire tool may be heated and cooled at approximately the same rate.

The angled shape here suggests a condition that tool designers try to avoid. Such sharp re-entrant angles as the one at "A" are objectionable because it is impossible to get uniform cooling there and internal strains are set up right at a point where service stresses will be concentrated.





This shape illustrates a light section adjoining a very heavy section—another condition that tool designers do not advise. It would be practically impossible to harden such a shape in water without cracking at the sharp corner. Even in oil, it would be difficult to quench safely.

Balance of cross-section

Figure 1 shows an under-cutting form-tool that would be hazardous to harden because it is made up of heavy and light sections joined by sharp angles. Figure 2 shows an improved design. Holes have been drilled through the two heaviest sections to balance the weight of metal. Also notice at "A" and "B" two suggested treatments to avoid the sharp angle at the base of the dovetail.

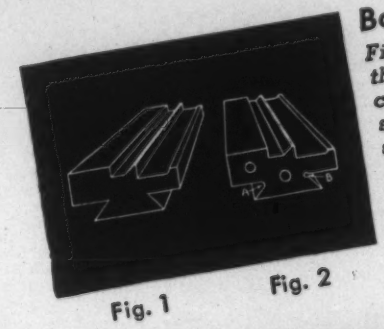


Fig. 1 Fig. 2

More metal needed here

Figure 3 is a blanking die (oil hardening) that failed in service. It was made from approximately a 3" x 2¾" x ½" section. Stresses set up in heat treatment and in service concentrated at points "A" and "B". A slightly larger section, 3½" x 2¾" x ¾" could have eliminated failure.

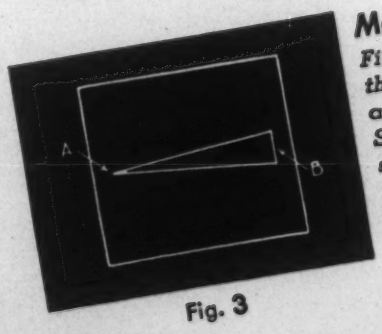


Fig. 3

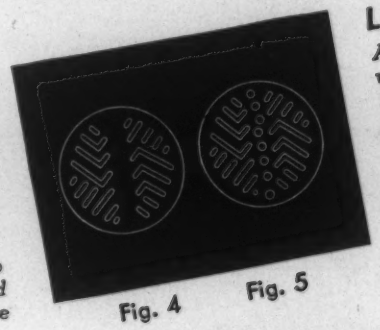


Fig. 4 Fig. 5

Less metal needed here

Another condition that often causes warping is shown in Figure 4. The heavy rib through the center tends to prevent shrinkage and would cause the die to become oval in quenching. Drilling holes, as in Figure 5, helps overcome the difficulty.

Use generous fillets

Figure 6 illustrates a design for twist drills that gave considerable trouble in service by breaking at "A". When a more generous fillet was allowed at this point, the trouble was eliminated and satisfactory results were obtained.

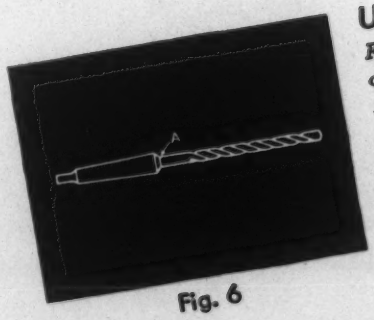


Fig. 6

"Tool Steel Simplified"
315 pages
205 illustrations
Available at cost in the U.S.A.—$1.00 a copy. ($3.50 elsewhere)

These are only a few tips from one *subject* covered in "Tool Steel Simplified". Get the benefit of *all* the useful information the book contains . . . make copies available to the toolroom men you want to train—to your "trouble shooters". Order as many copies as you need today.

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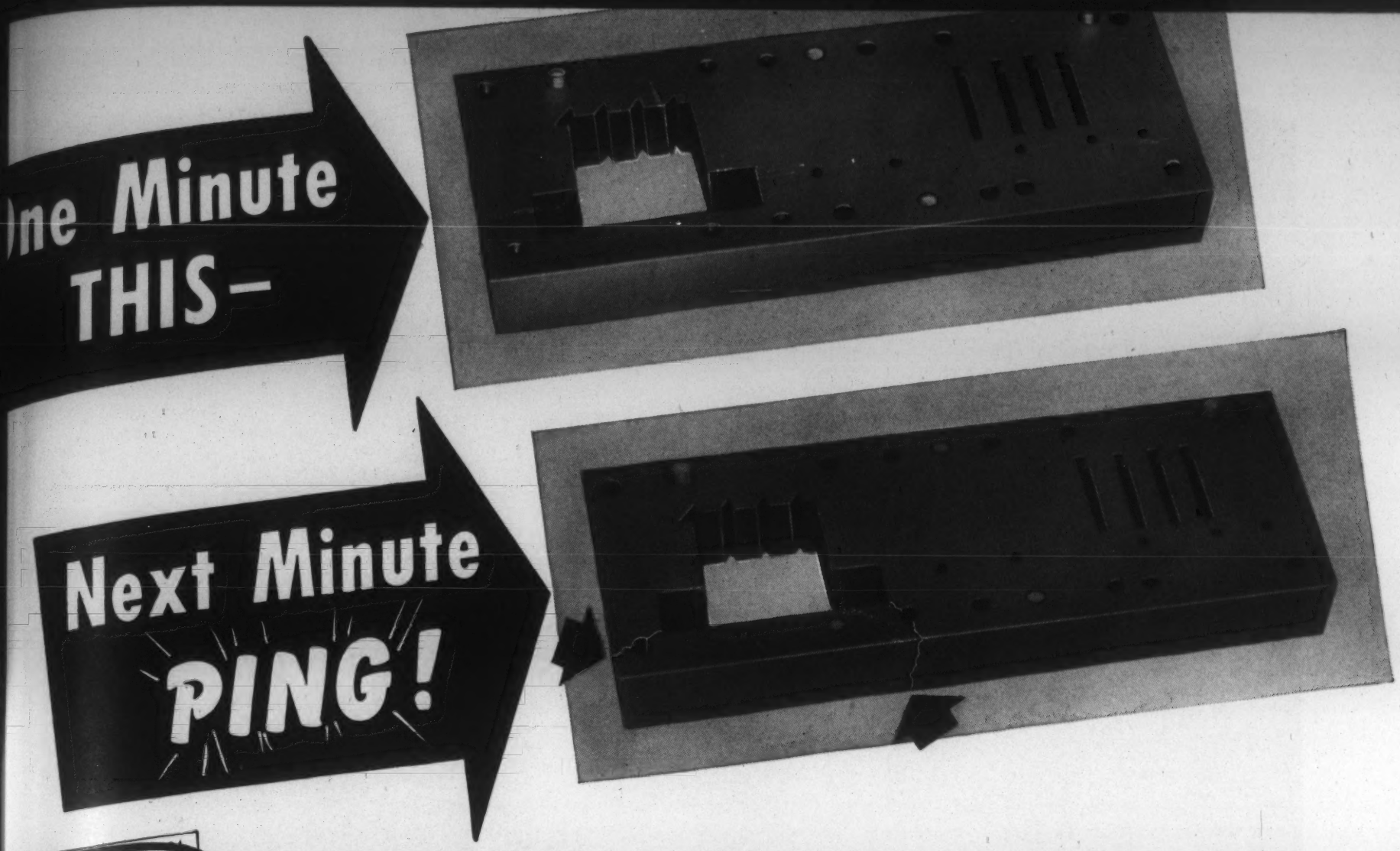

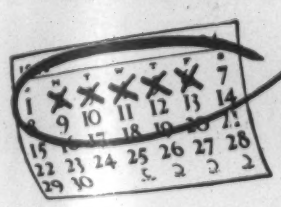

There goes 42 hours of Tool Making Time!

CRACKED IN HARDENING! What might have been a good tool is now a piece of scrap. Over a week of skilled tool making time thrown overboard. Now another week must go into the making of a new tool! *Why did the tool crack? What was wrong?* A number of things might contribute to tool failure, causing cracking in hardening. But the trouble may often be traced to some oversight of the relation of tool design to heat treatment.

Look for the Answer in "Tool Steel Simplified"

This subject of the relation of tool design to heat treatment is discussed in Chapter 12 of "Tool Steel Simplified". Here is *practical* information giving actual examples of designs that have caused trouble—and showing how they could have been avoided or corrected.

And this is only one of many subjects on which "Tool Steel Simplified" provides helpful information. It contains the kind of "how to" material you can use yourself and the kind you will want your toolroom men to have. Tool steel selection, tool making, heat treating, quenching, furnace atmospheres, "trouble shooting"—all are covered, in easy-to-understand shop language.

As an example of how *practical* "Tool Steel Simplified" is...how *useful* it can be . . . see the information on the relation of tool design to heat treatment given on the opposite page. It was extracted from Chapter 12.

More than 32,200 copies of "Tool Steel Simplified" are now in use—really used in several thousand plants like yours to "up grade" men—save time—"trouble shoot"—get better results.

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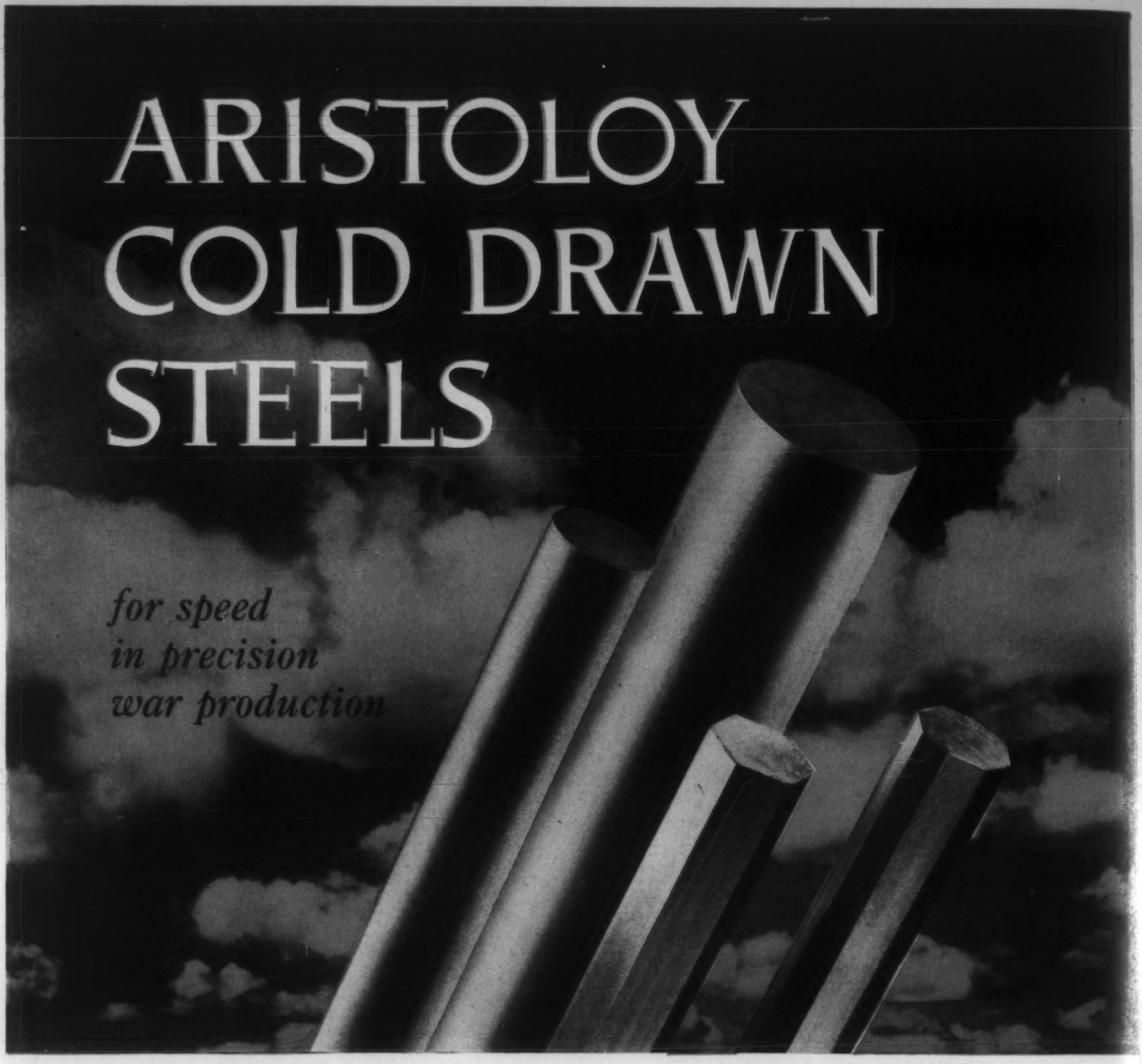

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WITH NO REJECTIONS

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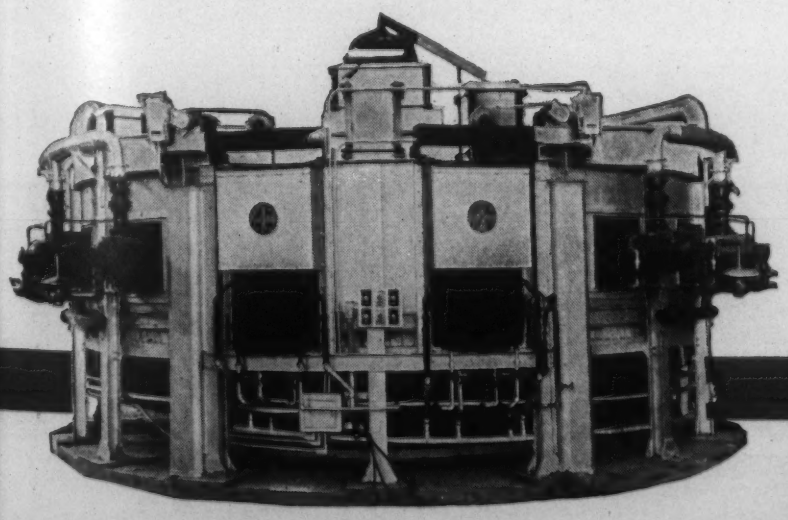

Patented construction rotary hearth forging furnace assures uninterrupted operation with uniform control of heating time and temperature. Each billet is delivered at the proper uniform forging temperature — no burned or cold steel — each billet forges the same.

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One Hagan 17′ rotary hearth forging furnace heated 2318 shell forgings during an eight hour shift—no rejections of any kind.

Operating crew on furnace consists of three men—one man charging, one man discharging and one man for relief.

Four additional furnaces have been ordered since the original installation went into service.

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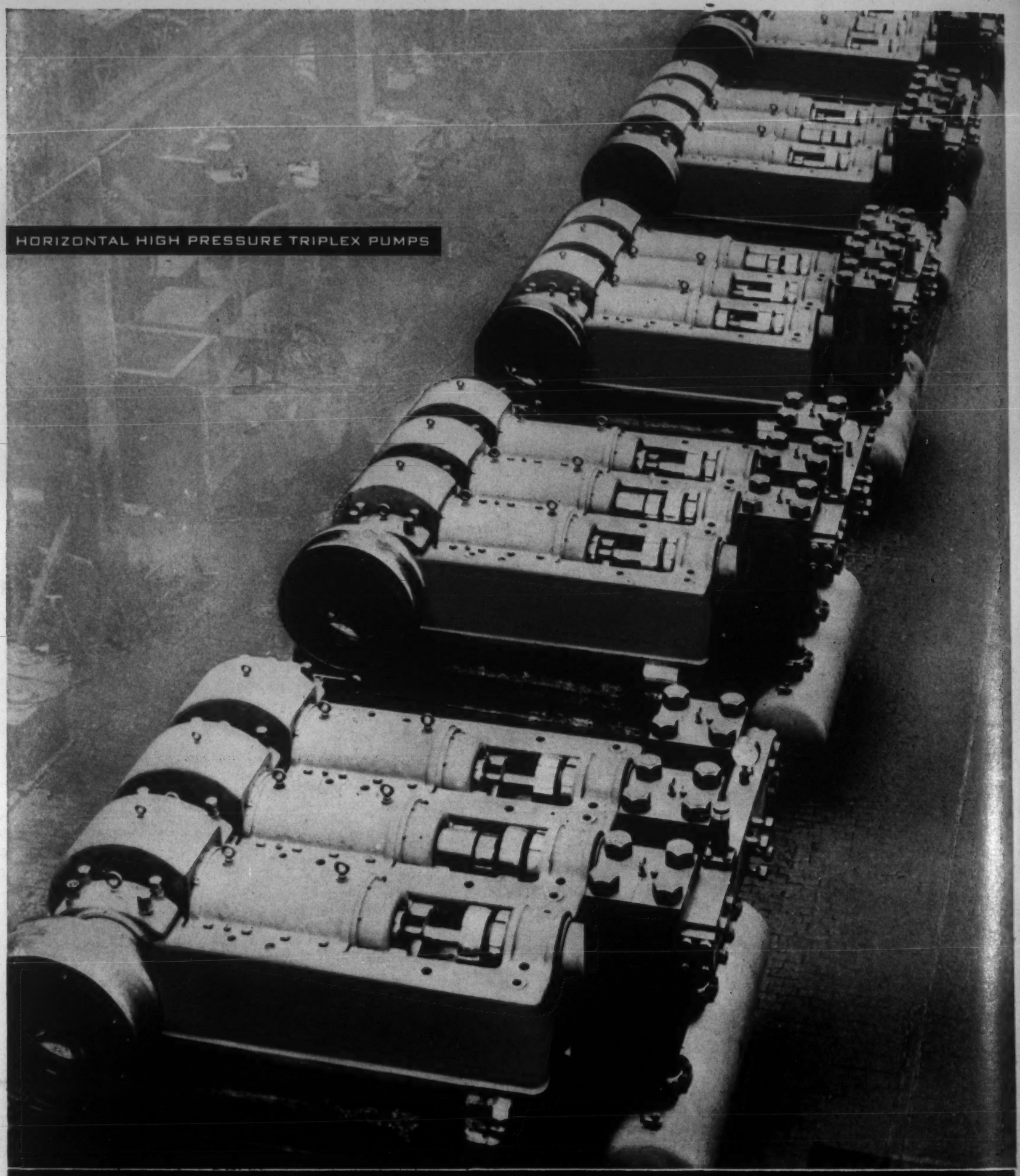

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Under the strain of all-out production, some equipment failures are bound to occur. Should it be a key machine or important piece of equipment in a vital industry, an extended delay may be serious. Replacement may take weeks or months—or even longer. • That's where Bronze repair welding has come to the rescue time and time again. Bronze welding has put fractured and broken machines back on the job in days instead of months . . . has reclaimed worn equipment by building up wear resisting surfaces. Costly or irreplaceable production equipment has been salvaged at a fraction of its original cost, and schedules have been maintained with a minimum of interruption. • Tobin Bronze*, developed by The American Brass Company, was one of the first all-around oxy-acetylene welding rods. Today, this low-melting-point rod is indispensable for repairing and reclaiming worn and broken equipment made of cast iron, malleable iron, steel or copper and its alloys. In addition to Tobin Bronze, other modified alloys such as Anaconda "997" (Low Fuming) are available for practically every Bronze welding requirement. • Investigate ALL the possibilities of this fast, dependable, low-cost method of repair that is saving days, delays and countless dollars in every branch of industry.

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If it's cast iron, steel, malleable iron or copper alloys—
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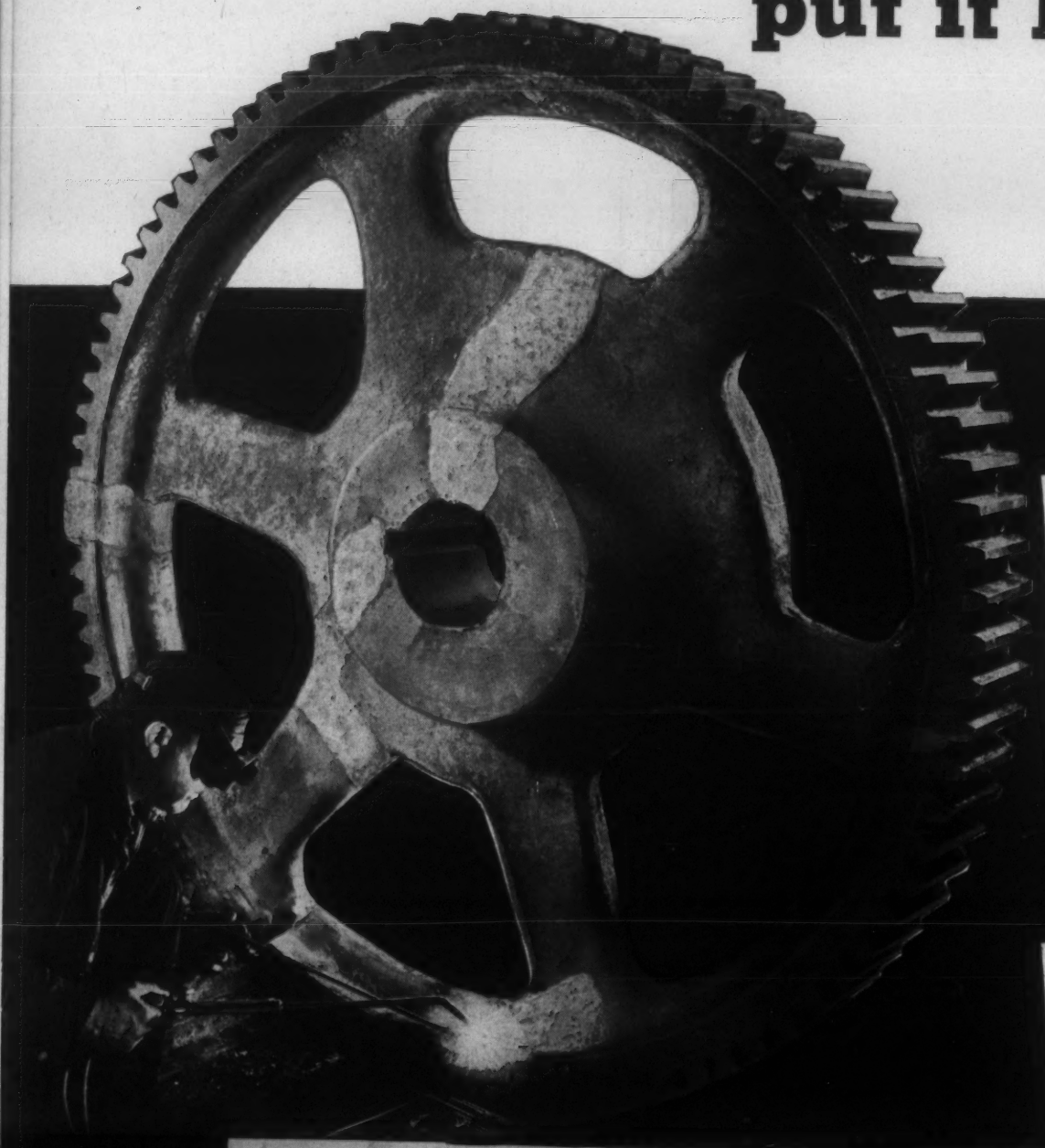
DON'T SCRAP IT-

Bronze welding will put it back in action!

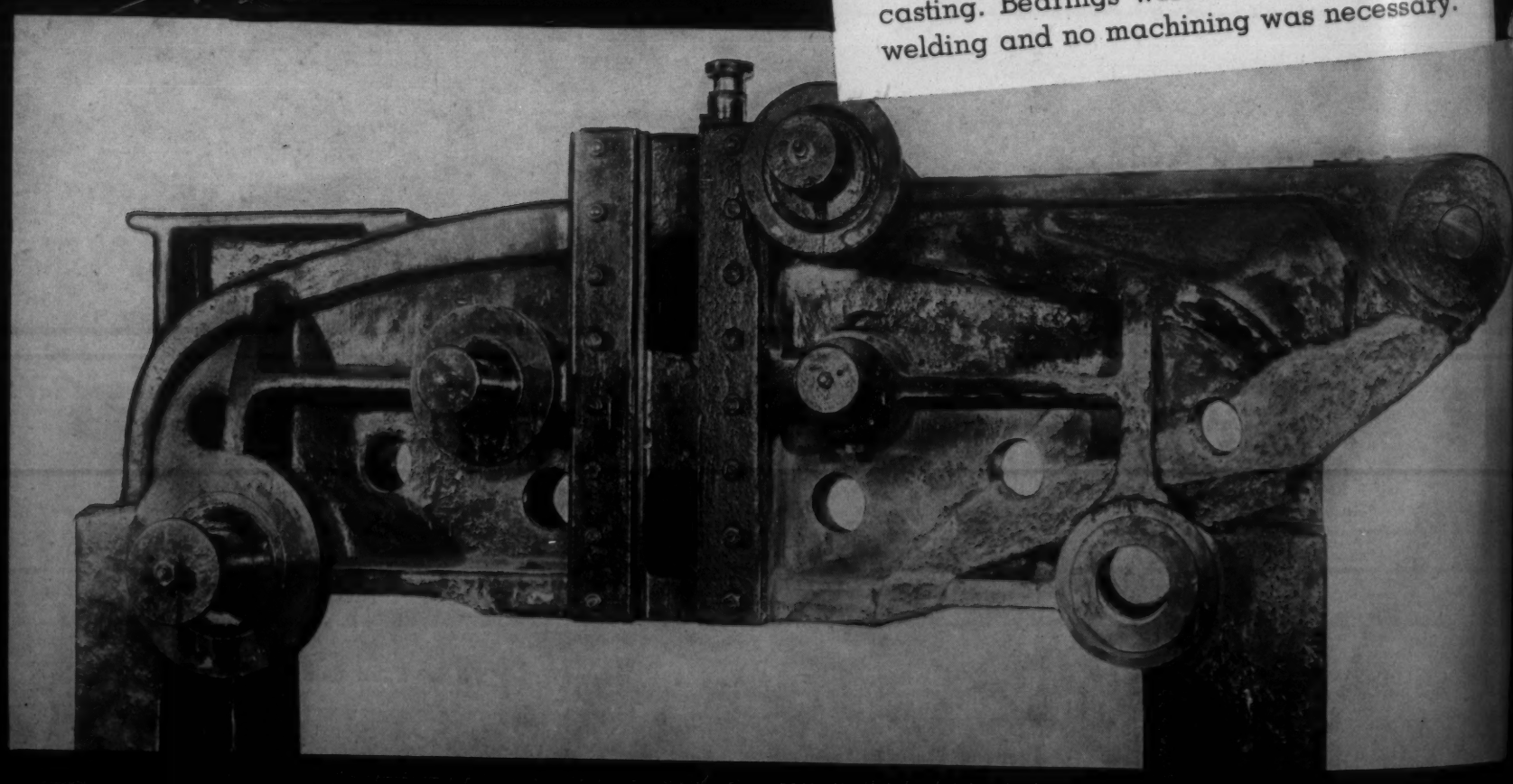


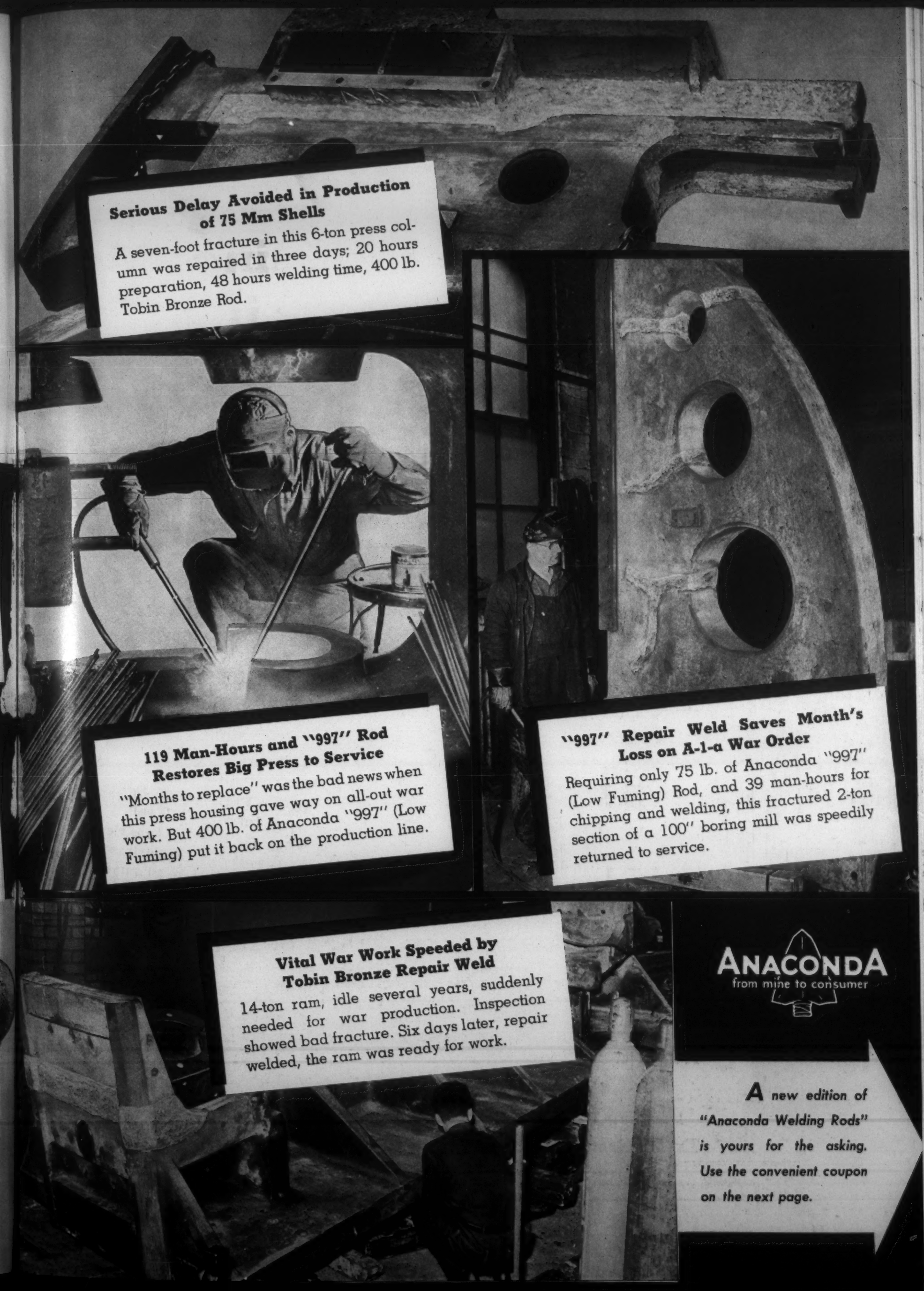
2½-Ton Gear—Broken in Several Places—What to Do?

A new one meant patterns, castings, weeks of machining—months of delay. Tobin Bronze repair welding had the gear back in operation—welded and machined—in less than a week.

15-Ton Press Crown Back in Action in a Week

Again Tobin Bronze to the rescue—1150 pounds of it—to restore this fractured 15-ton casting. Bearings were in alignment after welding and no machining was necessary.





Serious Delay Avoided in Production of 75 Mm Shells

A seven-foot fracture in this 6-ton press column was repaired in three days; 20 hours preparation, 48 hours welding time, 400 lb. Tobin Bronze Rod.

119 Man-Hours and "997" Rod Restores Big Press to Service

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Requiring only 75 lb. of Anaconda "997" (Low Fuming) Rod, and 39 man-hours for chipping and welding, this fractured 2-ton section of a 100" boring mill was speedily returned to service.

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14-ton ram, idle several years, suddenly needed for war production. Inspection showed bad fracture. Six days later, repair welded, the ram was ready for work.

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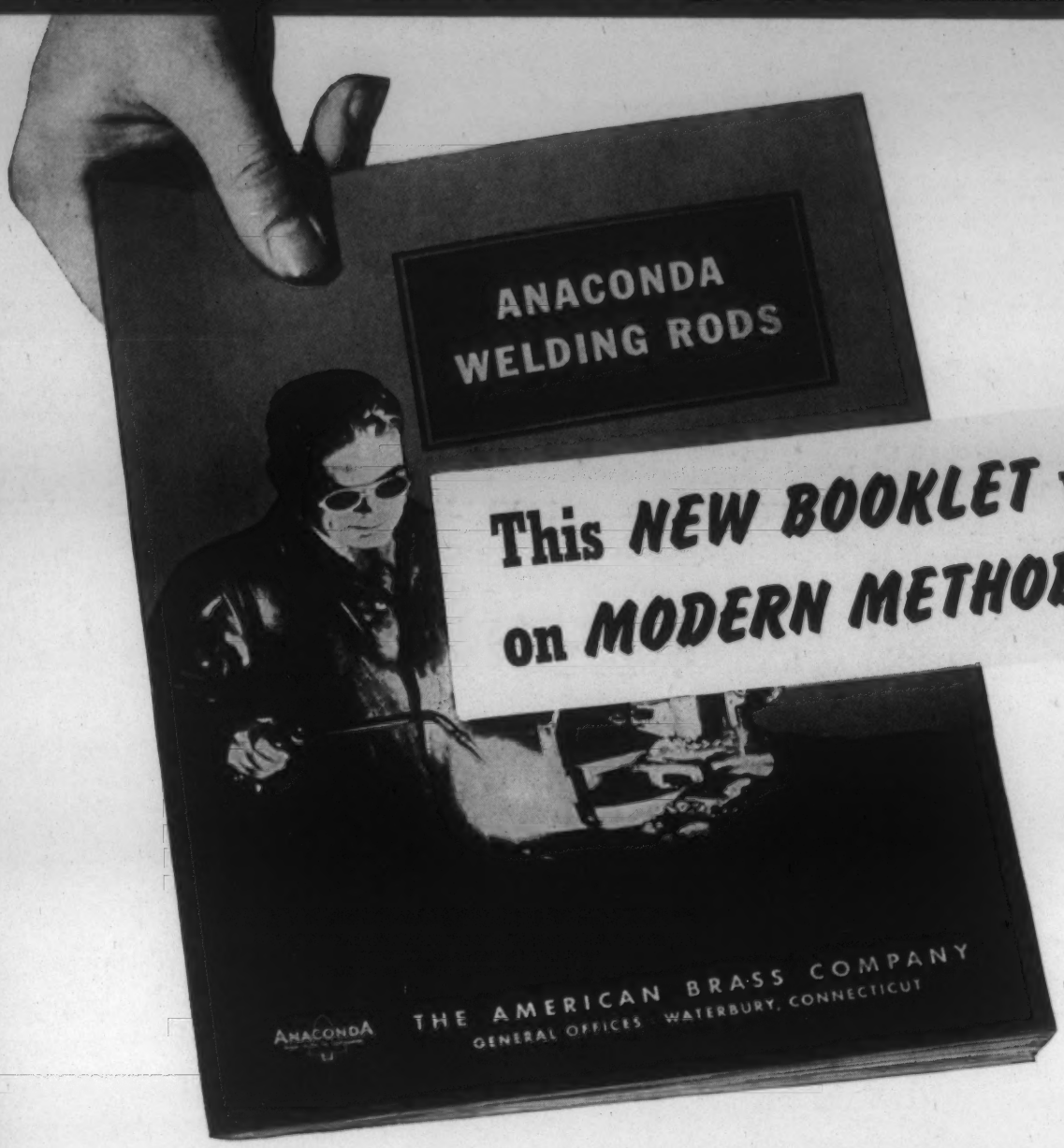

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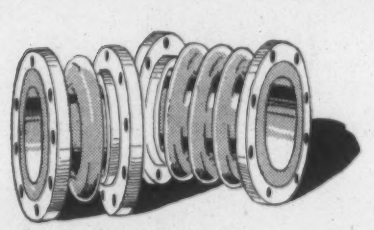
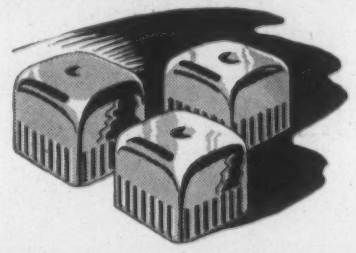
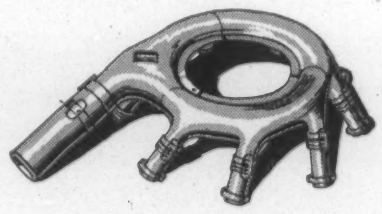


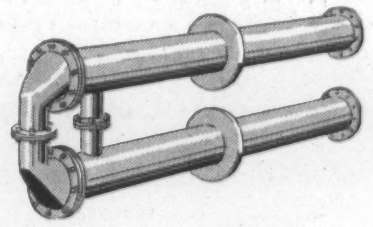
Expansion joints made of 18-8 stainless steel withstand corrosion in oil refinery piping.



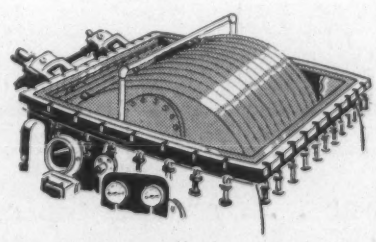
Bubble caps deep-drawn from 14 per cent chromium steel sheet are used in fractionating towers.



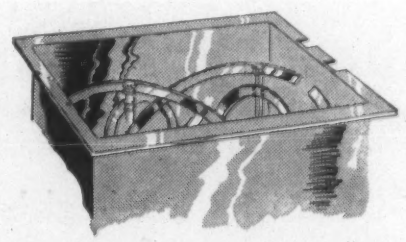
Aircraft engine collector rings of stainless steel stabilized with columbium, contain 1 to 2 per cent manganese.



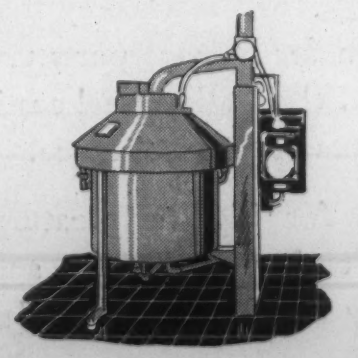
Heat exchanger of 18-8 molybdenum stainless steel resists hot organic acids under severe service conditions.



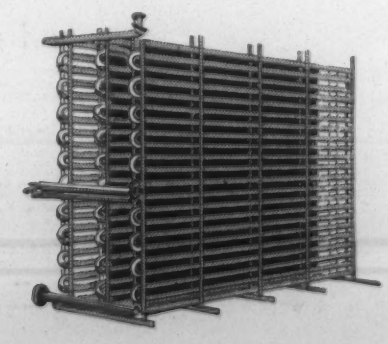
Stainless steel (18-8) drum and lining of this vacuum filter help keep products clean and pure.



Kneader made of 18-8 stainless steel is used in the manufacture of synthetic resins.



Irradiator used for increasing the active Vitamin D content of milk is made of 18-8 stainless steel.



Nitric acid cooler of 18 per cent chromium steel resists corrosive chemical action.

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OEM Photo by Palmer, in an Allegheny Ludlum Plant.

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[Accurate to 1/1000 of 1 per cent]

QUALITY in the manufacture of stainless steel—that is, high fidelity to the properties required, and consistent uniformity over shipment after shipment—requires constant control and research.

In Allegheny Ludlum laboratories, chemists weigh the elements of each stainless melt to determine its exact composition. Analysis is determined to 1/1000 of 1%, for each element in the steel. Nothing is left to chance that will prevent waste of these vital alloys, or protect the faithfulness of the steel to specifications.

That is the background of Allegheny Stainless when it comes to you as a raw material. And it's only half the story. The major importance today lays in what you *do* with the steel . . . how fast you turn it into finished war equipment and parts; how little of it is wasted in rejects or spoilage. Stainless steel is a critical material; even the use of a high alloy, where a lower one would do the job, is a loss out of the nation's reserves.

• Can you improve your use of stainless, either to save time or material? All of our technical resources, printed or personal, are ready to help you.

AL

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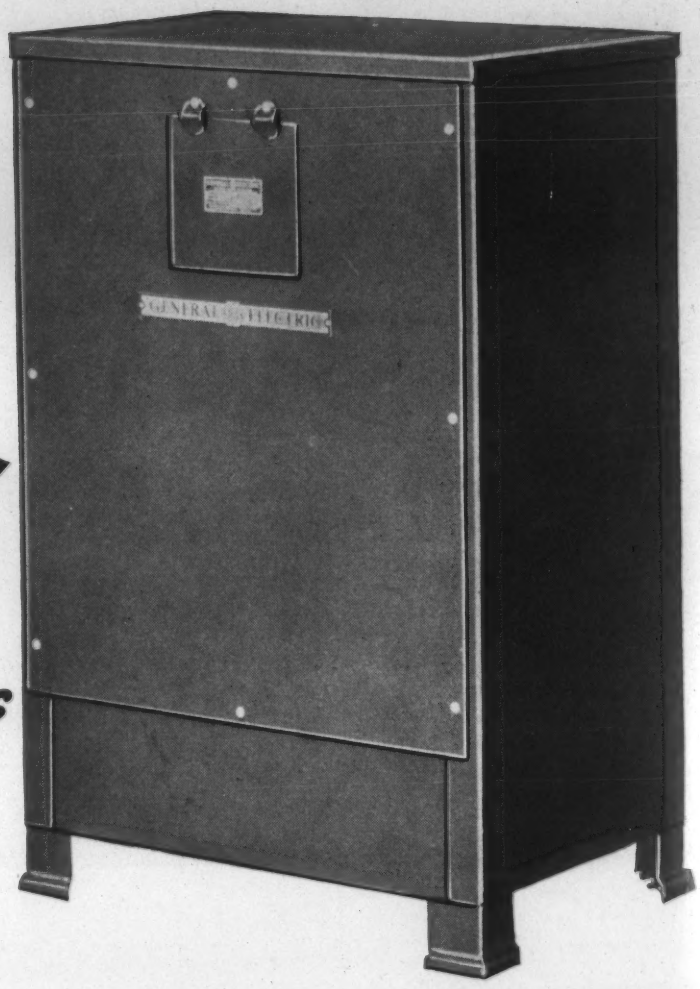
Allegheny Ludlum
STEEL CORPORATION
GENERAL OFFICES: PITTSBURGH, PENNSYLVANIA

For Greater Economy in Electroplating and Anodizing

USE G-E COPPER OXIDE RECTIFIERS



They Help You Save FIVE *Ways*

1. LOW FIRST COST. By standardizing the G-E Copper Oxide Rectifier to two sizes designed to be operated in parallel, series, or series-parallel to meet all requirements, manufacturing economies are realized by us—which means a lower initial investment for you.

2. LOW INSTALLATION COST. The compactly built G-E Rectifier requires no special foundation—which means it can be moved easily to the exact spot where it can work most efficiently.

3. LOW OPERATING COST. Current losses are reduced to a minimum by accurate control of A-c voltage input and D-c output. Further, the losses inherent in bus bars and tank rheostats are reduced to the minimum.

4. LOW MAINTENANCE COST. G-E Rectifiers have no moving parts to require care or to wear out and need replacing. The only exception is the low-powered, ball-bearing equipped fan which should be lubricated once a year.

5. FLEXIBLE FOR HIGH EFFICIENCY. G-E Rectifiers are designed specifically for flexibility in use. They can be installed anywhere since the regulator is installed adjacent to the tank and gives complete control of the rectifiers.

Get this new catalog now on the way G-E Copper Oxide Rectifiers for Electroplating and Anodizing will serve your needs. Write to Section A1227-112, Appliance & Merchandise Department, Bridgeport, Connecticut.

GENERAL ELECTRIC

Let's face the facts about Magnesium HEAT TREATING FURNACES

CLEAN HEAT, free of combustion gases, is supplied by this Despatch radiant-tube convection heater. Gas or electric. Very efficient indirect heating for all types of Mg. or Al.

AIRCRAFT PARTS of magnesium are heat-treated in Despatch furnace (above). Work chamber is 3′ x 4′ x 8′. Shelf-loading; manual or automatic lift type. Also used for solution and aging of Al. castings.

Why you can depend on a Despatch Furnace

Successful magnesium heat-treatment with Despatch furnaces in so many large plants doesn't mean we know everything about magnesium. No one does—yet.

But we do know exactly what's needed in furnace design and performance for proper heat-treatment of magnesium. Each Despatch furnace meets all requirements with ease. And in addition each offers many extra features particularly suited to high quality, large-scale production.

These Features Assure Good Results

1. Uniformity ± 5° F. guaranteed throughout entire heat range. Clean, recirculated convection heat, free of fumes, from radiant tube heater. Indirect gas fired. Handles all Mg. or Al. alloys. (Elec. models also available).

2. Dead Spots Avoided with controlled airflow from high volume fan. Adjustable ports in heat ducts allow perfect distribution through chamber and load.

3. Tight-Sealing throughout allows use of SO_2 gas. Reduces heat loss and improves working conditions.

4. Easy Handling provided by wide variety of dependable, smooth operating loading systems to fit all requirements. Saves labor.

5. Efficient Firing (Gas or Elec.) is obtained throughout entire heat range to give you the most from fuel used. Quick response to control equipment. Elec. systems use long-life elements.

6. Many Sizes: Prompt delivery available for standard sizes 3′ x 3′ x 3′ up to 8′ x 7′ x 15′. Pot type elec. models in all sizes to 60″ diam. by 60″ deep (working dimensions).

WIRE OR WRITE for a Despatch engineer. He will recommend a tested and approved standard Despatch magnesium heat-treating furnace for your plant. Free Bulletin 81 just printed; ask for it.

FURNACES FOR OTHER USES — to 1750° F.
Ask for complete information, photos, etc.

DESPATCH OVEN COMPANY MINNEAPOLIS MINNESOTA

2 ways to help win the war

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1

Save Scrap

Your help is needed to supply the millions of tons of scrap iron and steel necessary to speed vital production and help win the war. Collect the scrap from your plant NOW—then rush it to Steel Producers through regular Scrap Dealers. And keep it moving!

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Conserve Strategic Alloying Elements

The *use of N-A-X 9100 Series of alloy steels conserves critical alloying elements*—because in this versatile steel all strategic elements are held to an absolute minimum. N-A-X 9100 Series is supplied in two general grades, with and without molybdenum, all other components of this analysis being held constant.

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WAR DEPARTMENT
ARMY AIR FORCES
MATERIEL CENTER
OFFICE OF THE DISTRICT SUPERVISOR
CENTRAL PROCUREMENT DISTRICT
8505 W. WARREN AVE.
DETROIT, MICH.

July 13, 1942

PRODUCTION SECTION
CENTRAL PROCUREMENT DISTRICT
MANUFACTURERS' LETTER NO. 10
CHICAGO AREA OFFICE

SUBJECT: Cemented Tungsten Carbide for Cutting Tools

1. The following is quoted from memorandum, dated June 19, 1942, from the War Department, Headquarters. Services of Supply, Washington, D.C.:

"In the interest of conservation of critical alloys and of increased production, attention is directed to the following stated advantages of cemented tungsten carbide tools . . .

"a. One pound of tungsten in the form of cemented tungsten carbide for cutting tools will do the work of 70 to 100 pounds of tungsten in high speed tool steel. Furthermore, its use eliminates substantial amounts of chromium and vanadium which are considered necessary components of practically all high speed tool steel.

"b. Cemented tungsten carbide functions satisfactorily on almost all types of lathes and boring machines, particularly those of the sturdier construction. This is said to include all such machine tools manufactured in the last five years.

"c. Cemented tungsten carbide works efficiently on all steels above approximately .30 carbon and is effective up to 500 brinell or more.

"d. Cemented tungsten carbide will give two or three times the production of high speed tool steel in those operations to which its use is adapted and over a given run will require about one-fifth the number of grinds that standard high speed tool steel will require."

2. This information is forwarded by direction, Wright Field letter, EAZ-ar-72-2, (July 3, 1942).

3. Any requests for further information should be directed to the AAF Chicago Area Office, 20 N. Wacker Drive, Chicago, Illinois, Attention: Production Section.

For the District Supervisor:

HARLEY S. JONES
Lt. Colonel, Army Air Forces
Technical Executive

CENTRAL AIR CORPS PROCUREMENT DIST. OFFICIAL WAR DEPT. DETROIT, MICH.

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NOTE: In the reproduction of the above letter by Firth-Sterling, it is to be understood that it does not imply the WAR DEPARTMENT'S indorsement of any company's products.

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FIRTHITE

TUNGSTEN - TITANIUM CARBIDES

FOR STEEL CUTTING

FIRTHITE **T-04*** Universal grade for heavy duty, interrupted cuts, and coarse feeds, on older machines.

FIRTHITE **TA*** General-purpose grade for cutting steels under "average" conditions.

FIRTHITE **T-16*** The grade for fine, extremely fast machining of steel.

FIRTHITE **T-31*** Hardest, wear-resistant, premium grade for precision boring, etc.

* **TITANIUM** in these FIRTHITE grades makes possible better, faster, cheaper cutting of steel and at the same time permits tool prices comparable with those for high-speed steel. These FIRTHITE grades are made under one or more of the following patents on **TITANIUM** Carbides: 1,925,910; 2,023,413; 2,246,387; 2,265,010; Re. 22,073; Re. 22,074; Re. 22,166; Re. 22,207.

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SEGREGATED *Scrap...*

is your link to VICTORY!

Scrap salvage is a vital factor in the war effort. To be fully effective a scrap program must include methods for segregating and conserving critical alloying elements so urgently needed in the construction of tanks, guns, ships and planes.

Ferrous and non-ferrous metal scrap should be collected in separate containers at the machine where they are generated. Each class of high-speed tool steel and each type of constructional alloy steel should likewise be kept separate so that the alloy content can be returned to service.

Remember, — alloy scrap which is segregated, classified and labeled according to type and composition is a vitally important commodity today—and urgently needed to augment primary supplies of Nickel, molybdenum, tungsten, etc.

The metallurgical experience of our technical staff is available to aid you in these and other phases of metal salvage.

KEEP SCRAP MOVING INTO WAR PRODUCTION!

THE INTERNATIONAL NICKEL COMPANY, INC.
67 WALL STREET
NEW YORK, N. Y.

Feature Section

Goodbye, Gillett

Dr. Gillett, busy with direct war work, leaves our staff after 13 yrs. of extraordinary service. His parting message and ours appear on pages 1059 and 1061.

Centrifugally Cast Cylinder Barrels

Ford's practice in centrifugally casting aircraft engine cylinder barrels and some of the advantages of this metal-form, are described in a well illustrated article by Cone (page 1062).

Properties of Pure Nickel

The third and concluding instalment of Wise and Schaefer's article (page 1067) on the engineering properties of pure nickel presents data on forgeable electrolytic nickel after working.

Substitutes for Leaded Bronze

With satisfactory substitutes for high-tin babbitts and solders now generally available, attention is turning to reducing the tin consumed in bronzes. Dayton, Gillett and Balch (page 1072) discuss useful alternates for 80:10:10 leaded bronze.

Radiography of Spot Welds

The practical factors to be considered when making radiographic tests on spot welds are reviewed by Woods, Barrett and Dietz (page 1080) in the second and last instalment of their article.

Plating on Aluminum

Combining the light weight of aluminum with the oft-times superior surface properties of other metals is achieved by electroplating chromium, nickel, copper, etc. on aluminum. Yates (page 1084) tells how it is done and why it's a good idea.

Alternates and Substitutes in Ordnance

Section 5 of the "Alternates and Substitutes" Reference Tables is a 2-page presentation on ordnance equipment and parts (page 1089), with some design-change hints for everybody.

Metallurgical Engineering Digests

Making Graphitic Steel Castings

Of timely value is the detailed description by Joseph (page 1106) of the process for manufacturing various engineering parts of cast "Arma-Steel," classed as a useful alternate for wrought steels, bronzes, aluminum, etc.

Reclaiming Bullet-Jacket Scrap

The current use of composite gilding-metal-on-steel bullet jackets poses a problem of reclaiming the scrap, which is accumulating at the rate of 1200 tons a month. A War Metallurgy Committee Report (page 110) tells how the problem is being attacked.

Selenium Rectifiers for Plating Flexibility

A factual demonstration of the performance flexibility of selenium rectifier installations for electroplating is provided by Reinken (page 1124).

Heat Treating Tool Steels

Having trouble getting desired hardness in tool heat treatment, without cracking? A "composite" on page 1136 reviews some practical points in the light of new data presented at the recent A.S.M. convention.

Ship Welding

Reducing distortion in the welding of ships is still an important problem, despite prodigious steps forward in the last year. Grover (page 1142) applies a deft probe to the difficulty as he sees it.

Is Tin in Steel Really Harmful?

This question is significant today in view of the large amounts of "poorly detinned" scrap reaching the open hearths. Halley (page 1148) surprisingly enough says that a little tin is not harmful, and offers proof.

Malleable Iron Castings

Malleable iron is doing yeoman service in the cause of war production. A digest from *Canadian Metals* (page 1156) reviews some recent application developments.

Micromax, hung in improvised mounting, works while it waits for its steel panel to arrive. With it to help him, the furnace operator gets much closer control of a frit smelting furnace in plant of U. S. Stamping Co.

ENAMEL WARE MFR. STEPS UP PRODUCTION
By Using Micromax Control for Frit Furnaces

Faced with the need for a big increase in the frit-smelting capacity of its gas-fired pot furnaces, the U. S. Stamping Co. has found Micromax Pyrometers "very helpful" in securing the close, dependable temperature-control which is necessary to such an increase.

The instruments for one furnace consist of a Micromax Round Chart Recorder, range 1100-2300 F, and a 24-inch open-end Rayotube radiation-detector. The Rayotube is mounted in an iron tripod on the furnace roof. Its open-end tube extends through a hole in the roof (to which it is of course luted with fire-clay) and is aimed at the surface of the charge in one of the pots. The Micromax Pyrometer to which the Rayotube is connected records this radiation as temperature, so that when the workmen regulate the fuel valves, they are being guided by the radiation from the surface of the bath, instead of depending, as they formerly did, on the temperature of the furnace. The result is a uniformity of temperature never achieved before in these furnaces.

If the benefits of automatic temperature control of the furnace are desired in such an application, the best practice is to use a closed-end Rayotube, (instead of the open-end one) in the furnace roof, and to equip the valve and the Micromax Pyrometer for full-floating, proportional Micromax Electric Control. Under this system, the Micromax brings the furnace up to temperature on the basis of the closed-end Rayotube, and thus lets the furnace itself select the fastest heating rate which it can stand, and then, when at temperature, call for such heat as it needs to maintain its temperature.

The correct control system, for any war-busy furnace, will be gladly selected for you if you will forward details of your problem.

V depends on me!

Carburizing The New Alloys Is Helped By Four-Factor Control

The fine results being secured with the new low-alloy steels are, of course, largely due to successful heat-treatment — and, in more than a hundred plants, this heat-treatment consists largely of Homocarb Method Carburizing. For this method gives the close, constant, accurate control of carburizing, which is increasingly needed as the percentages of alloying metals are reduced. Homocarb regulates four important factors:

Typical Homo-Carburized parts for machine tools

1. Quality of Carbon Source. The gas which supplies the work with carbon comes from a special fluid which is of assured, uniform, lab-controlled purity. This gas is pushed into every part of the furnace load by means of a Homo Method fan; so that carburizing action is uniform throughout.

2. Supply of Carbon Source. A precise injector-pump automatically feeds the desired amount of Homocarb Fluid into the furnace, so that amount of carbon supplied is exactly what the metallurgist desires.

3. Time of Carburizing. The equipment's Micromax Controller records the length of time, so that this factor can be exactly regulated.

4. Temperature. A Micromax Recording Controller holds the temperature at the desired point, and records the heating rate, the temperature and duration of soak, and the time of removal from furnace. Records are permanent; analyzed in the light of results, they end uncertainty.

With these 4 factors under control, the heat-treat has a precision tool for carburizing; it saves time, space, work and rejects. For further information, see our Catalog T-623, or put your problem directly up to us.

Jrl Ad ENT-0600C(53)

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LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Ordinary words cannot convey the sincere regret which the editors of METALS AND ALLOYS *feel in announcing that this is the last issue under the guidance of Dr. Gillett as Editorial Director. For more than 13 years he has been not only our technical guide but also our editorial "voice," characteristic and unique in its timbre. In the midst of heavily increased direct war work at Battelle, as well as work for the War Metallurgy Committee, he has found it necessary to resign his official position with us, effective Jan. 1, 1943.*

His parting message—"From the Plural to the Singular"—is published below. It is followed by our tribute to the great and signal service rendered by him to the metal industries and to this magazine as its editorial director since its inception in 1929. —*The Editors*

From the Plural to the Singular

Since Vol. 1, No. 1 of METALS AND ALLOYS, July 1929, we have been using the editorial plural. Writing editorials has been a lot of fun, when the spirit moved to write one; an awful pain in the neck when the publication date drew near and we had to write one when there wasn't anything we felt a particular urge to say. In our own view, the best editorial we ever wrote was one of November 1929. From this we quote a part:

> A birch-bark canoe takes some skill in handling, and balances best with the heavier paddler in the stern. One who is accustomed to handling the stern paddle, and being responsible for steering the canoe, does not relish taking the bow paddle unless his companion is clearly superior in weight, in skill or both. One oddly resents moving from stern to bow; he feels that the bow is the place for the novice.
>
> When by accident, the writer happened to take the bow, and the youngster took the stern this summer, it was something of a shock to realize that the boy weighed as much as his Dad, the canoe balanced as well, and was steered as well as when the place of responsibility was filled by Dad. While the stern position is not yet definitely taken away from Dad, he can't have it all the time now, and in a few more years, his place will be in the bow.
>
> There is many a plant and many a laboratory where the craft would make just as much progress if the younger men were given the stern paddle now and then. The stern paddle is not likely to be given up readily; the older man sel-

Proper scrap metal segregation avoids loss of valuable alloys.

Irreplaceable Alloys Lost to War Program

Metallurgists Aid Needed

Metallurgists can give invaluable assistance to America's total war effort if they will help prevent the loss resulting from mixed alloy scrap. "Scrambled" scrap is never an advantage to steel mills, and it takes from war industries great quantities of scrap and irreplaceable alloys.

In many American plants segregating and classifying scrap is a co-ordinated effort by metallurgists, the design department, operating heads, supervisors, and the machine operators. New men are carefully instructed on the importance of segregating various kinds of scrap—tote boxes, designated by name and color, are removed from machines whenever a new run calls for a different kind of steel. Specially marked bins are used to accumulate quantities suitable for unit shipments. Whenever there is doubt about any scrap, it is checked by rapid qualitative tests.

Nickel-bearing scrap salvaged in twelve months in one plant contained 110,000 lbs. of pure nickel—another shop saved 75,000 lbs. of nickel and 35,000 lbs. of chromium.

You, with your knowledge of alloys and alloy steels, can advance the war program by rechecking scrap segregation methods to make certain that no precious alloy is lost.

SHEETS • STRIP • TIN PLATE • BARS • PLATES • FLOOR PLATE • STRUCTURALS
PILING • RAILS • TRACK ACCESSORIES • REINFORCING BARS

Dedicated to Victory

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dom thinks of it, and the younger man has too much deference to suggest it. . . .

* * *

Metallurgy needs stern paddlers. Perhaps you have some in your organization who are still paddling bow. It's not a bad plan to let them try the stern. If they are stern paddlers, they're likely sooner or later to go from the bow of your canoe to the stern of some other canoe. While the old steersman's pride may be hurt to sit in the bow, after all, on a long cruise, it is restful to shift from stern to bow, now and then. We suspect, too, that many people would live to take more and longer cruises if they didn't insist in staying in the stern too long.

Time has passed since then. The "boy" is now "Dad," and we are "Grand-dad." In respect to METALS AND ALLOYS, we long since left the stern position, and now we leave the bow, stepping out of the canoe altogether. Even bow paddling requires energy that cannot be spared in view of the other responsibilities we are currently carrying, directly connected with the war effort.

In our first editorial we expressed the belief that the progress of metallurgical engineering depended on the finding of new facts by scientific research and the speedy application of those facts to practical use, and the hope that METALS AND ALLOYS might serve to record the facts and help to hasten their application. Whether the hope has had a reasonable degree of fulfillment, we leave others to judge. At any rate, trying to make it true has been a pleasant task.

Many have helped in making it pleasant. Authors who have sent in bang-up articles; authors who have submitted articles that we thought needed revision on the basis of comments from the Editorial Advisory Board and who made those revisions, always with good grace, often with sincere thanks for the comments; the Editorial Advisory Board, originally 15, of which three have died, the other 12 are still serving; the publishers; the others of the past and present editorial and digest staff; the readers who have often criticized constructively, sometimes even given a word of praise; and, especially, those who sent in "Chuckles."

To all these, "Gentlemen, (also Janet Briggs and Frances Clark), I thank you."

—H. W. Gillett

Dr. Gillett, We Thank You!

Since its first issue in 1929, METALS AND ALLOYS has been editorially an engine with an extremely efficient flywheel — Dr. Gillett. One of his most useful "flywheel" functions in these last 13 years has been his review and criticism of the editorial comment prepared by others for publication in this department. *This* editorial, however, has not been read by him.

We cannot let Gillett walk out of our pages without reminiscing a bit about the things he brought into them and, thereby, into the metal industries. His greatest — though perhaps not the most obvious — contribution was the major part he has played in maintaining the high level of technical accuracy of articles and statements published in this magazine. Of almost equal value has been the tremendous improving influence he has exerted on metallurgical engineering practice in this country and abroad through his "searchlighting" editorials and through his articles — all the more effective because of the characteristic and completely natural homespun idiom in which they were written.

Gillett would consider it in bad taste for us to "eulogize" his rare technical talents and critical ability, so we'll just say, briefly, that they are extraordinary — a fact that even our most casual reader knows anyway. To have had full use of them for these first 13 years of our publishing existence is something for

(Editorial continued on page 1091)

Centrifugally Cast Cylinder Barrels or

Pouring a ladle of alloy steel from the electric furnace into one of the revolving molds.

or Airplane Engines

In the face of protests and arguments that an airplane cylinder barrel could not be anything but a steel forging, Ford metallurgical engineers demonstrated that it could be satisfactorily made as a centrifugal casting. Thousands of these are now being made and incorporated in airplane engines each day, and another outstanding centrifugally-cast product is thus added to the group already made by the company.

This article describes in part how these cylinder barrels are made and finished—many of the details of alloy composition and processing unfortunately having been deleted by the censor. —The Editors

by EDWIN F. CONE

BY SUBSTITUTING CENTRIFUGALLY CAST products for forgings, the metallurgical engineers of the Ford Motor Co., Rouge Plant, Dearborn, Mich., have effected not only marked economies but have decidedly advanced the art of casting products centrifugally. And, it is claimed, an equally good if not better product is being made. A good example is an airplane engine cylinder barrel.

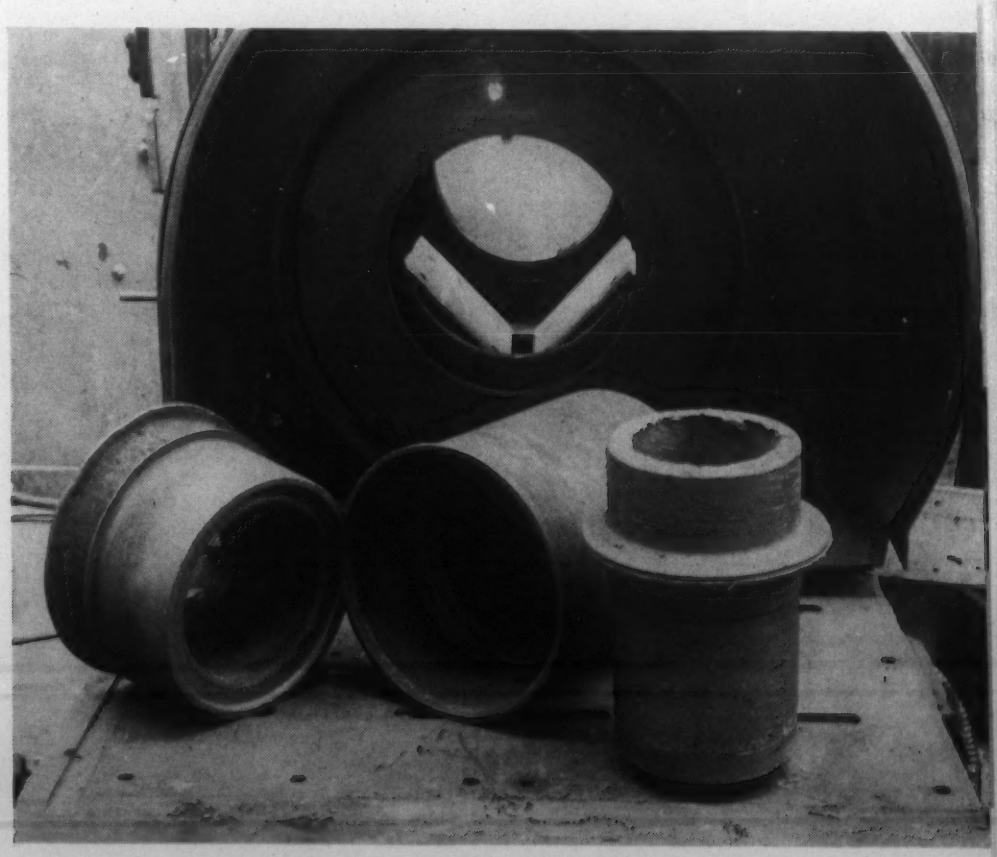
In a new and imposing $21,000,000 building, erected within the last two years, Ford is now making airplane engines on a large scale. For these, cylinder barrels are of course essential. It was the practice earlier to make these of forgings. But when the idea was suggested of producing them as castings, it was frowned upon. Ford metallurgical engineers, however, soon demonstrated that a highly satisfactory cast barrel could be made. Today they are exclusively used in the engines made by Ford.

The Ford casting process is a simple one. On revolving circular platforms there are centrifugal machines, simple and practical in design, 8 on each platform. As the platform revolves, a mold of special alloy steel is inserted in each machine in which it is revolved at a rapid speed. Into one end of these revolving molds, steel is poured from hand operated ladles. In a very few seconds the casting has solidified and at one side of each revolving table the mold is removed from the machine and the casting sent on its way for further processing.

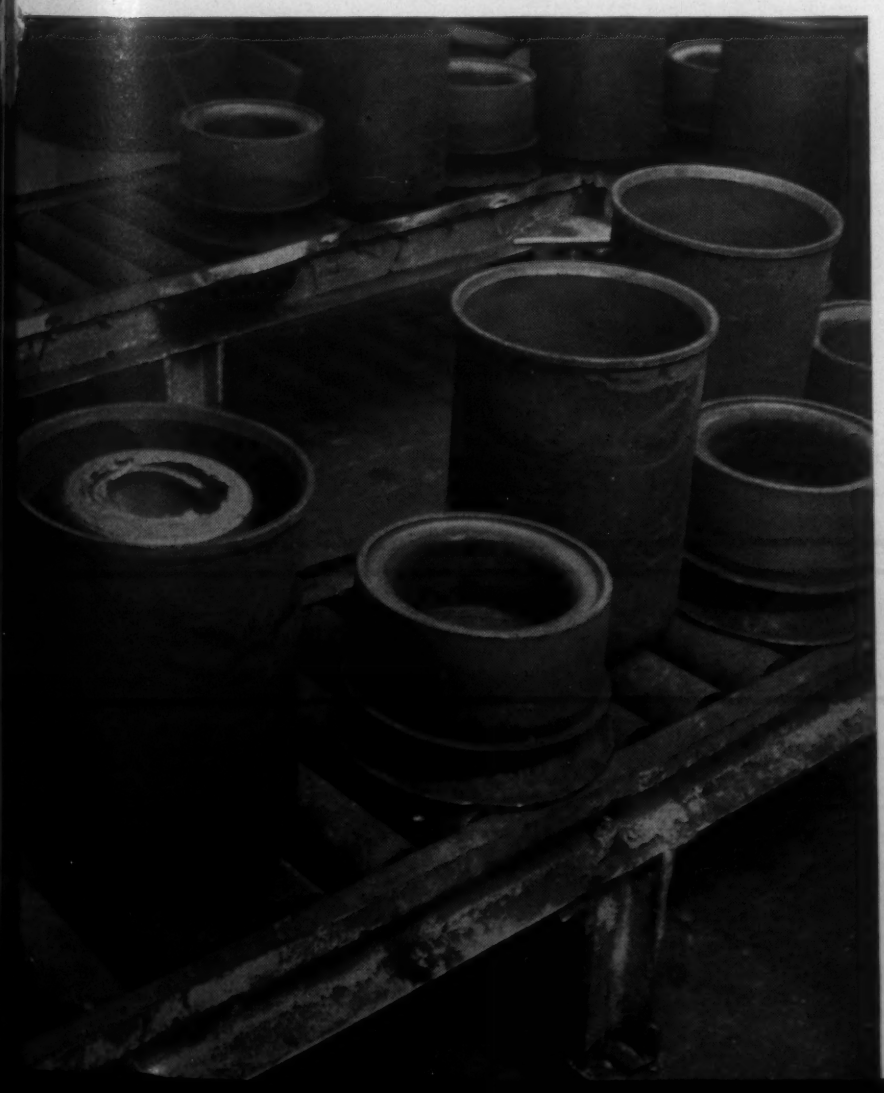
Melting and Pouring

The cylindrical mold is made in two sections. As indicated by one of the illustrations, the main section is so constructed as to form the upper portion of the barrel. Into this there is inserted and clamped down a smaller piece which forms the other part of the cylinder barrel. Between the two sections is an aperture which forms the flange or protrusion on the side of the barrel.

A mold and a centrifugally-cast cylinder barrel in front of one of the casting machines.



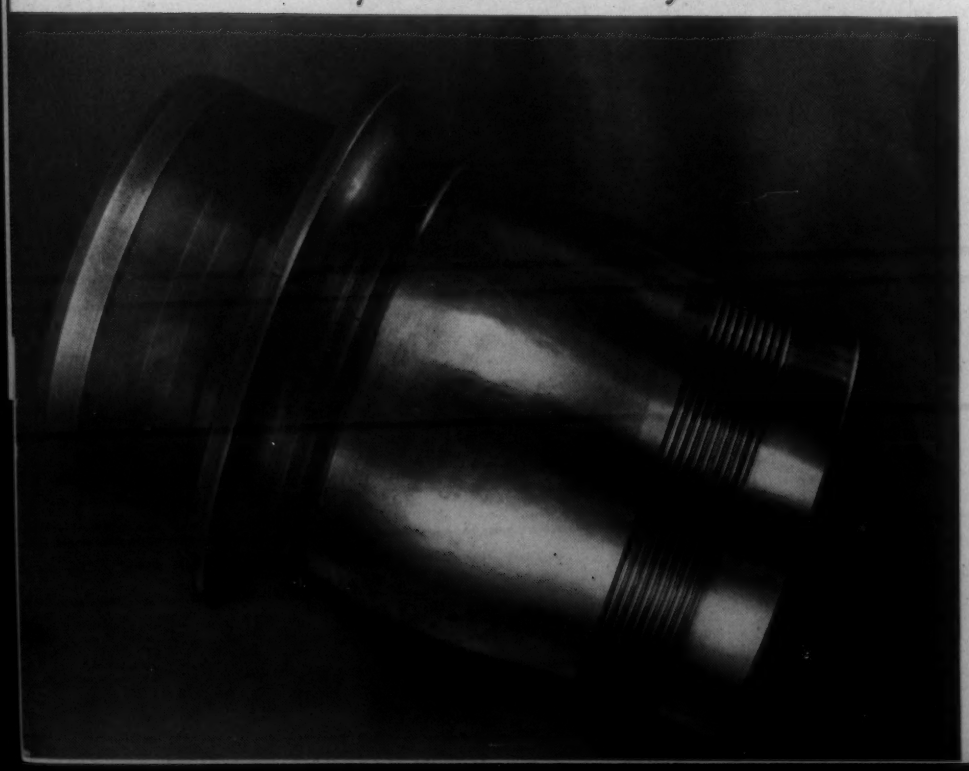
The centrifugal molds of forged alloy steel in various stages of assembly.



Appearance of the hot cylinder barrel in the casting machine just after pouring.

Relative appearance of the centrifugally-cast and forged cylinder barrels.

Appearance of a centrifugally-cast cylinder barrel after submission to a hydrostatic test.



As indicated these molds are made of a special alloy steel and are typed forgings. They must be of a quality to stand the severe heat of the metal and other conditions and these requirements have been met. The life of each mold is comparatively short. Present operating conditions assure the production of several thousand barrels a day during two shifts. When the equipment has been expanded, a considerably increased output is planned.

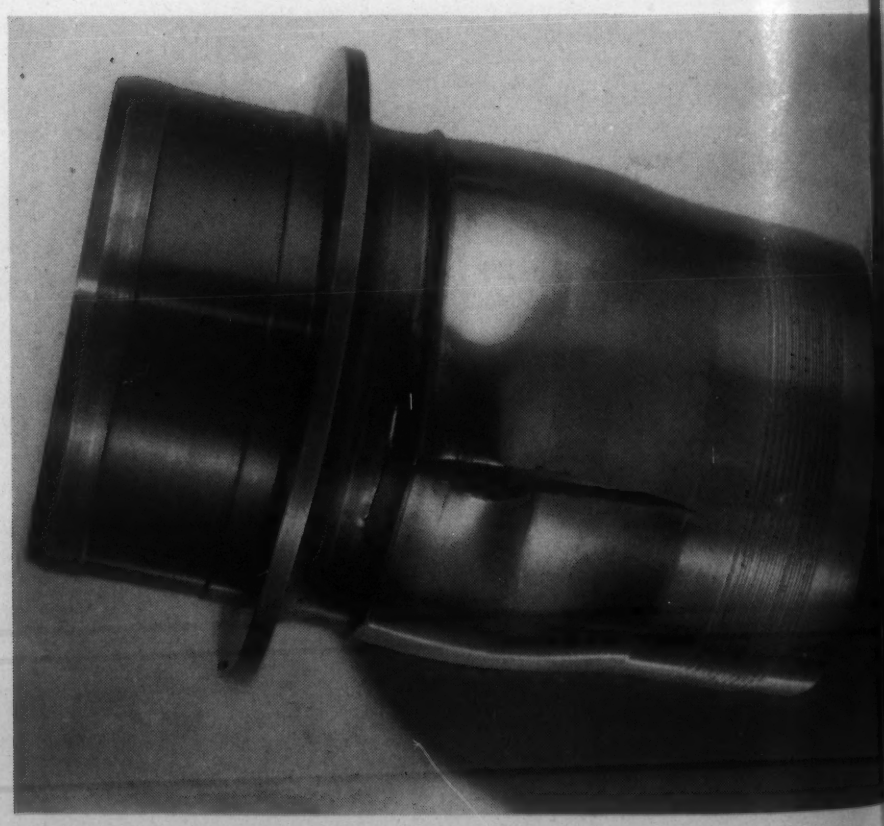
An alloy steel is incorporated in these cylinder barrels. The entire equipment is located in one section of Ford's foundry department where so many remarkable castings have been produced.

In 15-ton basic arc electric furnaces the alloy steel for the barrels is made to specified composition. These are located just adjacent to the centrifugal barrel casting department. The alloy steel is made on these basic bottoms to keep the phosphorus and sulphur low. At the proper time cycle, the steel is transferred to a 10-ton acid electric arc furnace located just opposite the revolving tables carrying the centrifugal casting machines. At suitable intervals small ladles are filled from this holding or reservoir furnace and poured into the revolving molds. One of the illustrations shows the steel being poured into the machine and another shows end of the hot cylinder barrel just after pouring.

Heat Treating and Machining

Soon after the castings are taken from the molds, they are transferred to a gas-fired heat-treating fur-

Result of a similar hydrostatic test carried out on a forged cylinder barrel.



nace. In this they are held at a fairly high temperature and cooled in the furnace. This treatment is followed by shot blasting to remove scale, etc.

In another department of the plant the cylinder barrels are rough machined—first on Footburt boring machines the inside diameter is rough turned, and later the outside diameters are adjusted on Fay lathes.

At this point a hardening heat treatment is applied. In suitable gas-fired furnaces the barrels are heated, quenched in oil and then drawn. Each barrel is tested for hardness at this stage of the operation.

The last operation in this department consists of rough machining each piece to grinding size on Bullard automatic machines. After this the barrels are degreased and then subjected to severe magnetic inspection for imperfections. Here the loss is very low.

Grinding and Assembling

From these operations the rough machined and inspected barrels are transferred to the new aircraft engine plant where they are completely finished and ready for assembling in the engines. The finishing of each barrel is done entirely by many grinding operations. The details of these many different steps on numerous up-to-date grinding equipment cannot be told here. The tolerances and the various radii which are prescribed are successfully and rigidly adhered to. Each barrel is ground inside and outside.

Toward the end of these grinding operations the section of the barrels naturally becomes very thin. An interesting feature of the final grinding steps on the outside diameter is the use of a water cooling arbor to prevent any harm of burning the metal from the heat caused by friction—each end of the barrel is plugged and the barrel filled with water under specified pressure while the final grinding is accomplished.

Another operation in the finishing of each barrel is bonderizing—each barrel after semi-grinding is bonderized after degreasing.

Properties and Inspection

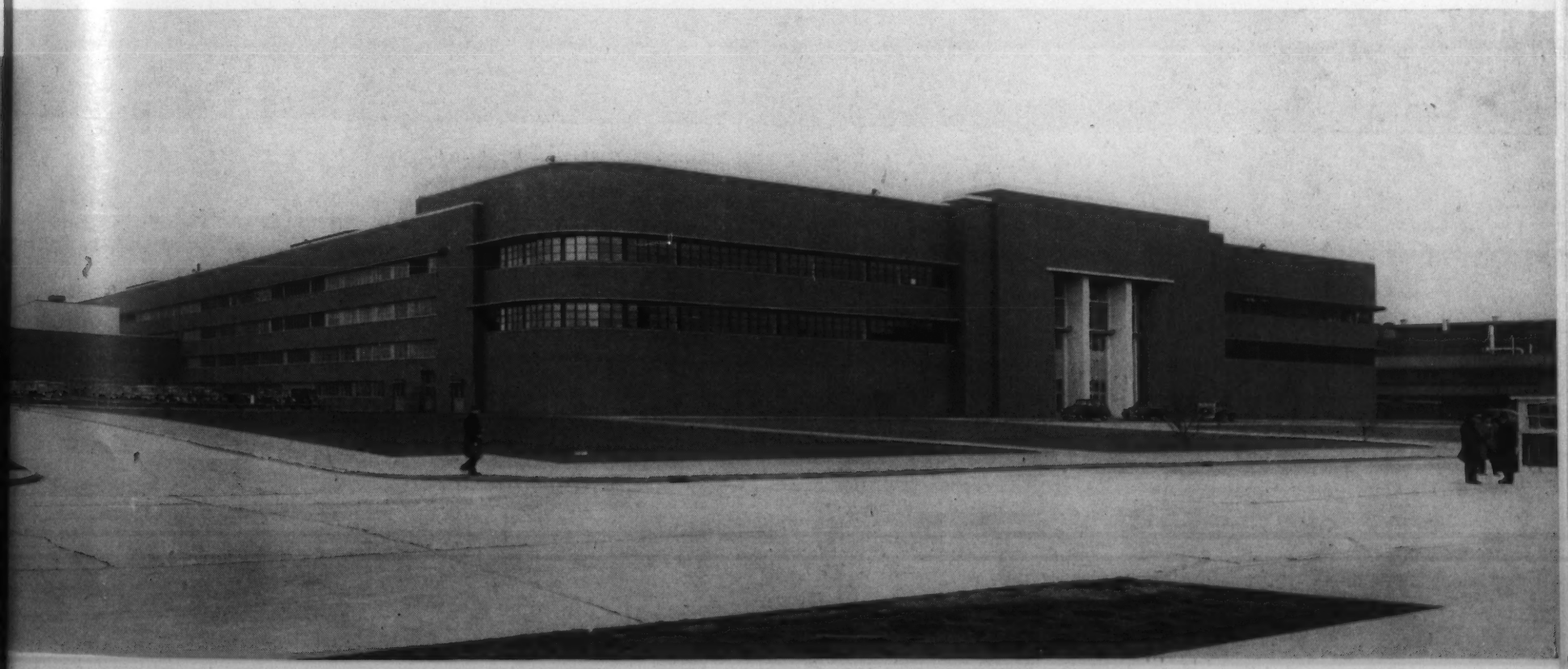
When all grinding operations are completed, and in a plant filled with the most up-to-date equipment and under artificial light closely resembling daylight, each barrel is again subjected to close magnetic inspection. In this the average loss is again very low.

A statement by R. H. McCarroll, chief metallurgist of the Ford company, is to the effect that the "condition of both rings and barrels that we have seen seem better when the centrifugally cast cylinder is used."

As to the bursting strength of the barrels made by the forging and casting processes, it has been found by repeated tests that the centrifugally cast barrel is superior. Illustrations of the respective barrels after these tests are herewith supplied.

This general description of what Ford metallurgical engineers have done in producing centri-

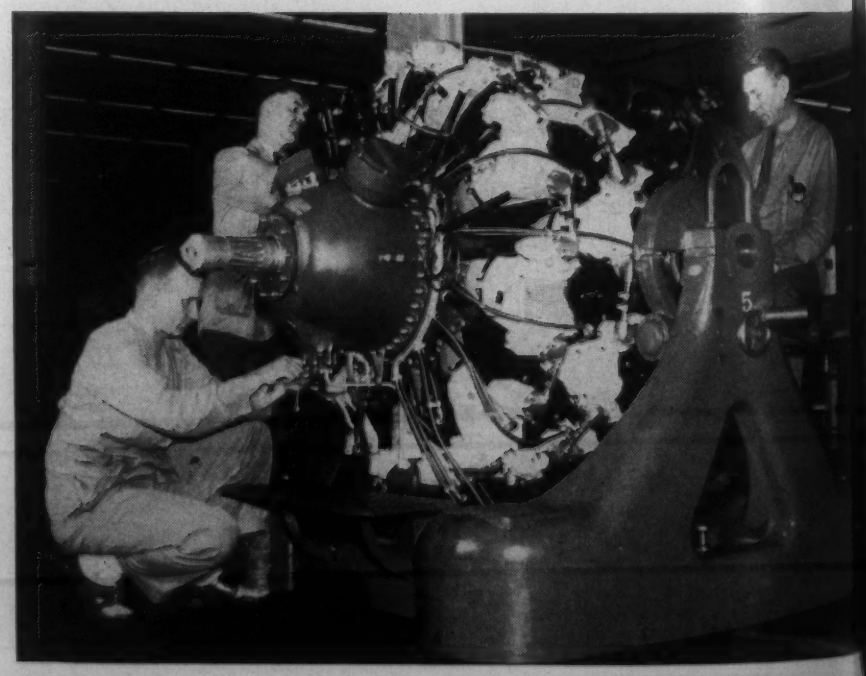
The new $21,000,000 airplane engine building of the Ford Motor Co., at River Rouge, Mich.



Assembling the cylinder barrels in the aluminum alloy cylinder heads.

fugally cast airplane engine cylinder barrels is but one of several similar achievements. Transmission and rear axle gear blanks are now cast centrifugally with a marked saving in time, material, machining and labor. This development was fully described in an article in METALS AND ALLOYS, Oct. 1938, p. 275. Other products now made by centrifugal casting include landing gear axles, solid projectiles and so on. The latest product is a centrifugally cast large sprocket wheel for tanks—the product *as cast* as to size ready for installation after hardening.

By methods like these, plane engine and other war equipment parts can be and are being produced with drastic reductions in manufacturing costs and production time. The centrifugal casting process is a large factor in the conservation of metal and faster production for war.



An impressive view of one of the completed airplane engines. Some of the cylinder barrels can be detected.

The Properties of Pure Nickel—III

—Effect of Various Elements

The first two instalments of this compilation of data covered highly pure nickel (September) and commercial Grade "A" nickel (November). This third and concluding instalment reports on the effect of various elements on the properties of regular electrolytic nickel that has been treated to produce a sound, workable ingot. —*The Editors*

BY E. M. WISE and R. H. SCHAEFER

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Alloys can be made by melting, sintering or, in some cases, by electrolysis, but it seemed that the most useful information would be secured by preparing small heats of alloys using regular electrolytic nickel as the base, making single additions thereto and finishing the heats with minimal amounts of magnesium and silicon to secure sound forgeable ingots which would insure reliable property values. It is to be noted that commercial alloys will in general contain several addition elements and are produced under different conditions, so that their behavior will differ from the simpler alloys herein considered.

Chill cast 10-lb. Ajax induction melts were prepared in magnesia-lined crucibles from regular electrolytic nickel, the special alloy additions, and finished with 0.05 per cent Si and 0.05 per cent Mg to produce ingots which could be quite readily cast and forged. The analyses of the melts are shown in Table I. The trace of carbon found in the base composition melt was picked up in melting. This amount is probably also present in the other melts. The alloying elements were added in the form shown in Table II where the purity is also indicated.

The ingot heads were sawed off, drillings taken for the analyses and the remainder of the ingot was forged down to a flat 2 x 6 x 5/8 in. and a round 5/8 in. in diameter. The flat was machined to 1½ x 4 x 3/8 in. for work hardenability and recrystallization data and the round machined to 3/8 in. in diameter for electrical resistivity specimens. The latter was then swaged to approximately 0.1 in. diameter with suitable intermediate electrical annealing during which the wire surface was coated with boric acid to prevent oxidation. The machined flats and swaged wires were then coated with boric acid, annealed in dried hydrogen (with the exception of the carbon containing melts for which nitrogen was used) for 1 hr. at 900 deg. C. (1652 deg. F.) and water quenched. All the data subsequently reported herein are for material initially in this condition.

Before considering the experimental data it might be well to point out that after this annealing treatment the silicon, manganese, iron, and copper are all in solid solution. The solubility of carbon at this

Table I—Analyses of the Melts

Melt No.	Alloy Added	Analyses
T-12808 (base)	0.05% Si*, 0.05% Mg*	0.027% Mg, 0.03% Si, 0.012% C
T-12819	0.05% C	0.043% C
T-12820	0.10% C	0.077% C
T-12821	0.25% C	0.176% C
T-12809	0.15% Mg	0.12% Mg
T-12887	0.25% Mg	0.23% Mg
T-12811	0.45% Mg	0.38% Mg
T-12815	0.20% Si	0.20% Si
T-12816	0.50% Si	0.51% Si
T-12812	0.50% Mn	0.47% Mn
T-12813	2.0% Mn	1.90% Mn
T-12888	5.0% Mn	4.83% Mn
T-12837	0.50% Fe	0.54% Fe
T-12834	2.0% Cu	1.99% Cu

* *These additions were made to all heats in addition to the alloying element indicated.*

Table II—Alloying Elements Added

Element	Form of Addition	Analyses
Nickel	Commercial electrolytic nickel	Ni + Co 99.95 (type analysis)
Carbon	High carbon nickel	1.5% carbon
Magnesium	Nickel magnesium	31.49% Ni, 68.32% Mg. 0.16% Fe
Silicon	Nickel silicon	24.05% Si, 74.36% Ni, 0.8% Fe
Manganese	Manganese	97.29% Mn, 1.49% Fe, 0.74% Si
Iron	Armco iron	
Copper	O.F.H.C. copper	

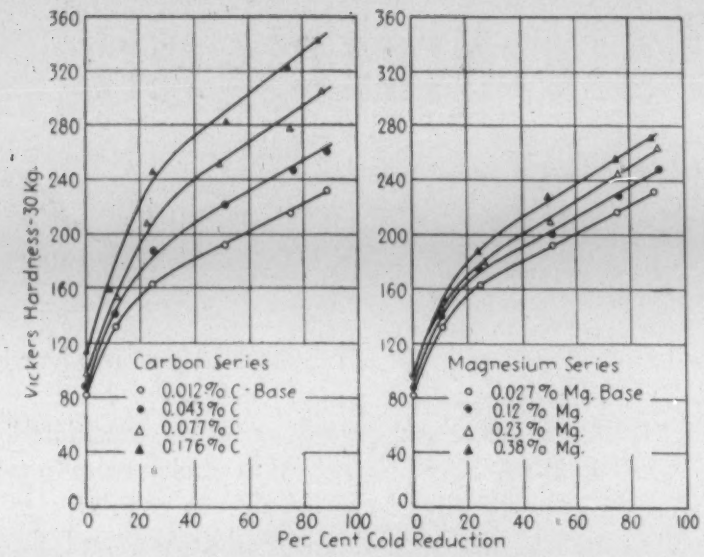


Fig. 10. Effect of carbon and magnesium on the work hardenability of nickel.

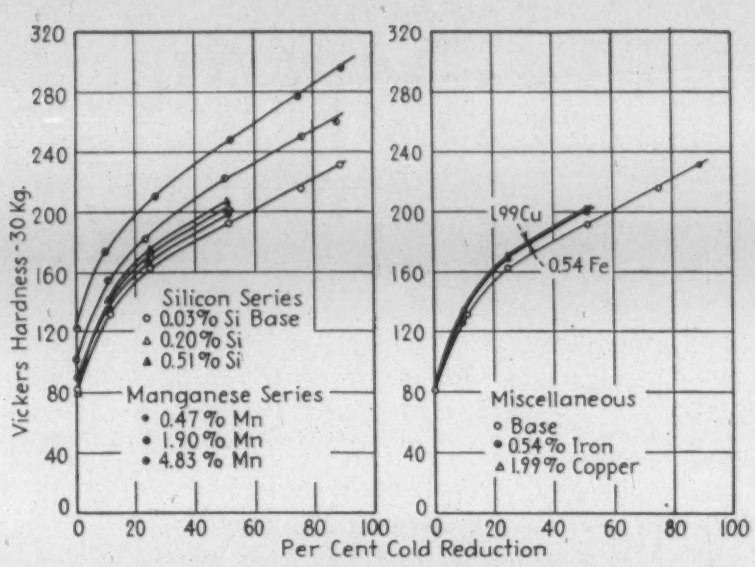


Fig. 11. Effect of various elements on the work hardenability of nickel.

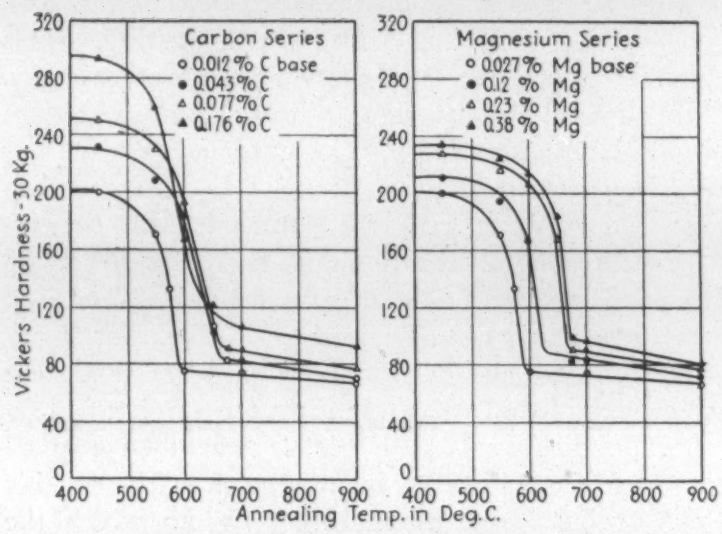


Fig. 12. Effect of carbon and magnesium on the recrystallization temperature of 50 per cent cold-rolled nickel.

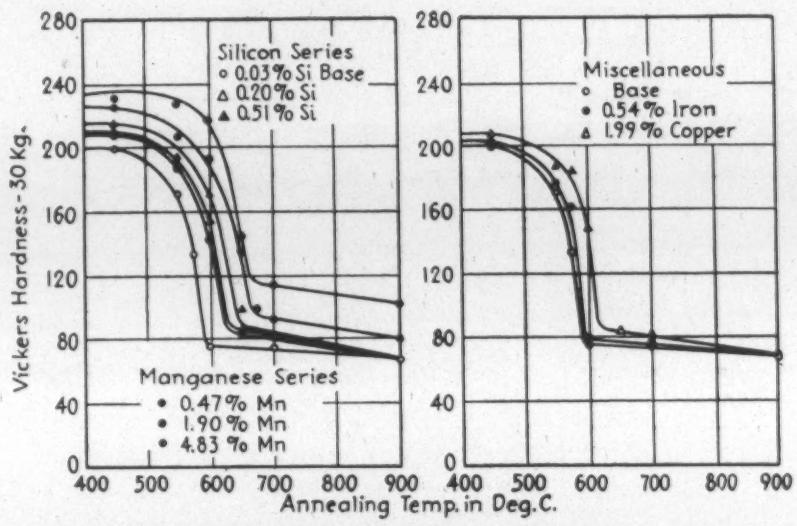


Fig. 13. Effect of various elements on the recrystallization temperature of 50 per cent cold-rolled nickel.

temperature is 0.15-0.16 per cent so that in the two low carbon melts (0.043 and 0.077 per cent) the carbon will all be in solution. In the case of the 0.176 per cent C melt a trace of graphite would be present. With regard to magnesium, it may be noted that this metal reacts with oxygen and sulphur with avidity so that some small portion of the indicated amounts may be so combined.

Work Hardening

The work hardenability curves for each melt, shown in Figs. 10 and 11, were determined by measuring the Vickers hardness (30 kg. load) of the machined flat specimens as annealed and after approximately 10, 25, 50, and, in most cases, 75 and 90 per cent cold reduction by rolling. Each stage of reduction was secured in from one to three passes, depending on the hardness of the material. The curves are quite similar in shape in that they consist roughly of two parts. Initially the rate of work hardenability is quite high and continues to decrease to approximately 25 per cent reduction above which the rate is substantially constant for a given alloy. It will be noticed that in addition to increasing the general hardness level, alloying also tends to increase the work hardening rate over the range 25 to 90 per cent reduction.

Annealing Behavior

In a study of the recrystallization behavior of metals and alloys, so many variables affect the softening temperatures that an arbitrary selection of certain of these factors must be made to limit the work to a reasonable extent. Some of these conditions are the prior grain size, amount and nature of the cold work, composition, annealing time, etc. For the present investigation it was decided to determine the recrystallization habits of these alloys after they

had received 50 per cent cold reduction by rolling and had been held for 1 hr. at the annealing temperature. It cannot be overemphasized that the data herein presented apply to these and only these conditions.

The 50 per cent cold rolled specimens were coated with boric acid to prevent oxidation, annealed for 1 hr. at temperatures ranging from 450 to 900 deg. C. and water quenched. After washing to remove the boric acid, the Vickers hardness (30 kg. load) of each specimen was determined. The resulting curves are shown in Figs. 12 and 13. In general the "temperature of complete recrystallization," which we have termed the slightly extrapolated intersection of the precipitate drop in hardness which occurs with partial recrystallization and the gently decreasing line which is a measure of grain growth above this temperature, was bracketed within 25 deg. C. That this nomenclature is correct may be seen from Figs. 14 to 19 which show the microstructure of the base composition after annealing between 550 and 900 deg. C. The 450 deg. C. annealed specimen was omitted since its structure was identical with that of the as-rolled material.

It is interesting to note that although recrystallization is not complete until 600 deg. C. was reached, the 550 deg. C. specimen showed partial recrystallization occurring at the highly stressed or favorably oriented positions such as grain boundaries and slip planes.

Temperatures of complete recrystallization ranging from 593 deg. C. for the base material to a maximum of 670 deg. C. for the 0.38 per cent Mg alloy were found. In all cases the rate of change of hardness with annealing temperature suffers a sharp break at the above defined recrystallization temperature. The effect of these alloy additions on the solid solution hardness is perhaps best evaluated from the hardness after annealing at the tempera-

Fig. 14. Microstructure of Heat T 12808, as rolled. 100X.

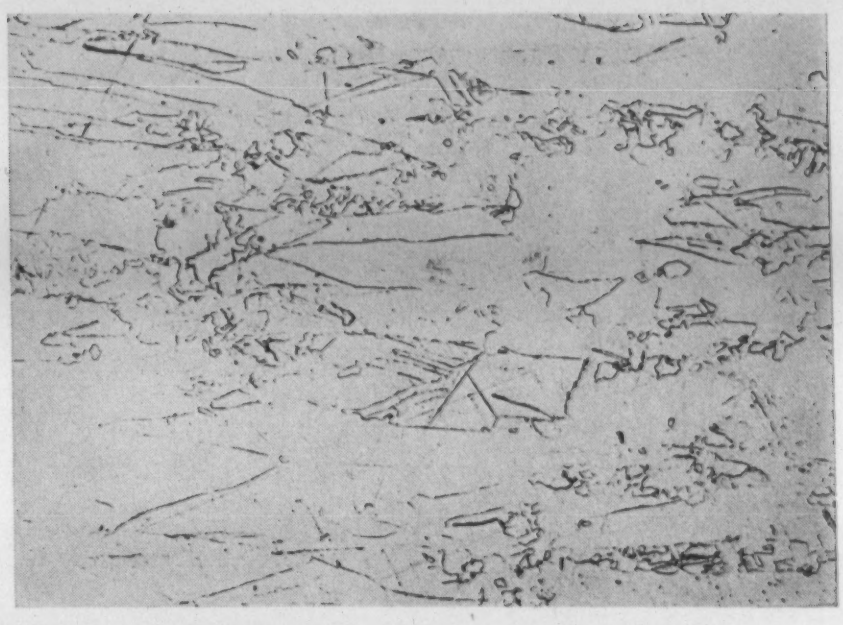


Fig. 15. Microstructure of Heat T 12808, annealed at 550 deg. C. for 1 hr. 100X.

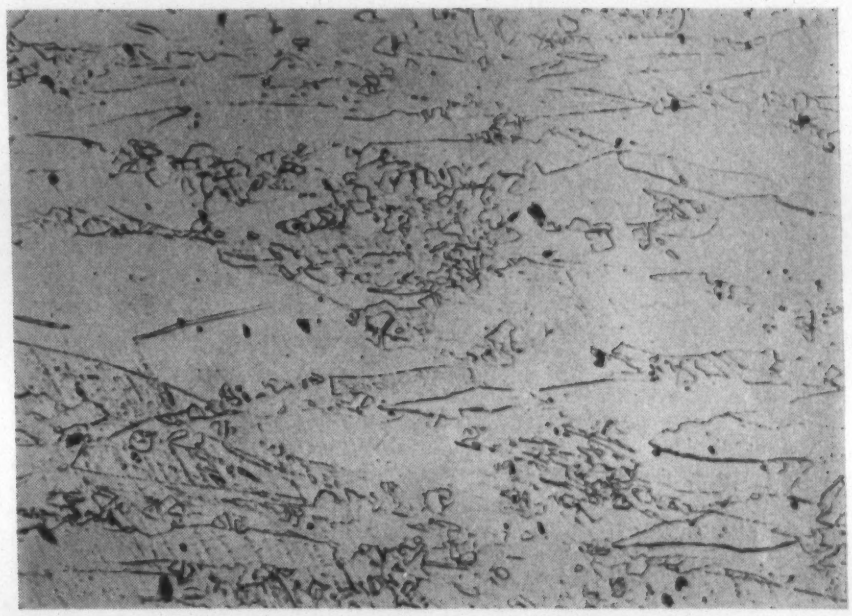


Fig. 16. Microstructure of Heat T 12808, annealed at 575 deg. C. for 1 hr. 100X.

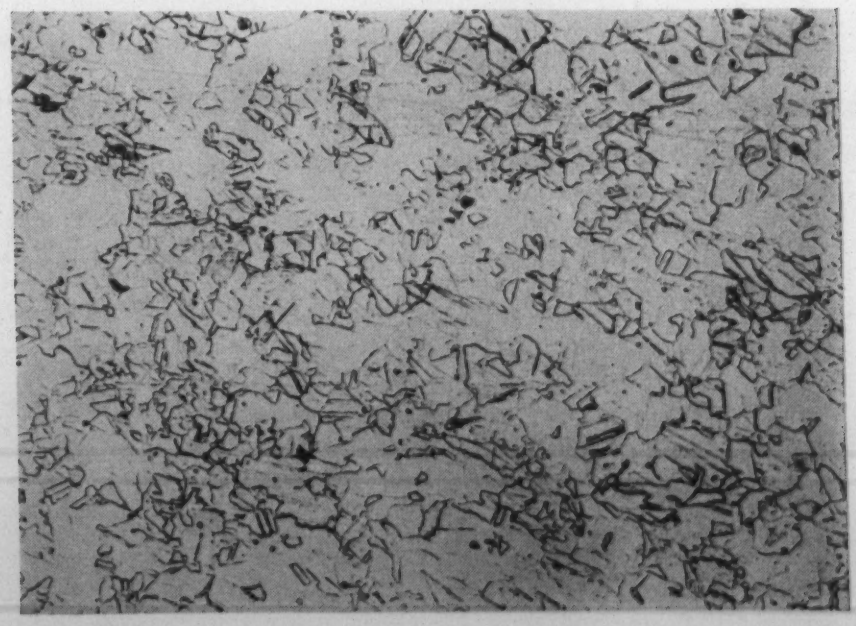


Fig. 17. Microstructure of Heat T 12808, annealed at 600 deg. C. for 1 hr. 100X.

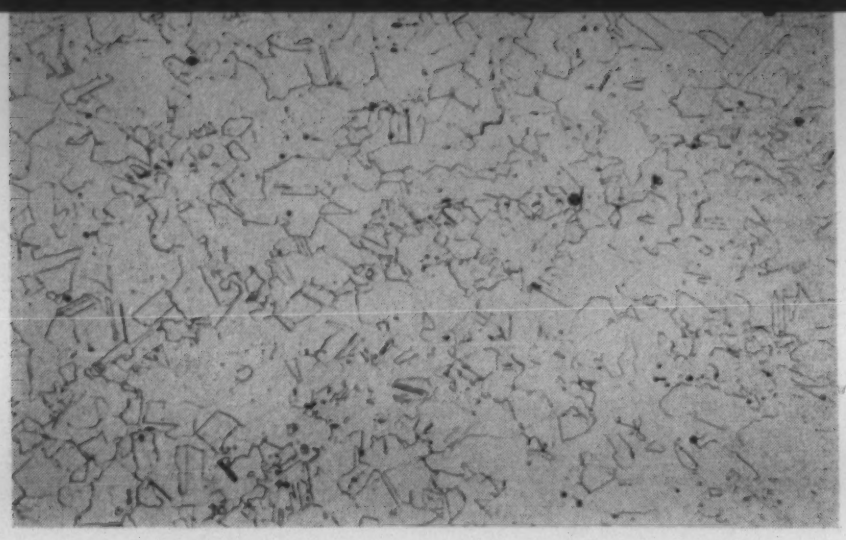


Fig. 18. Microstructure of Heat T 12808, annealed at 700 deg. C. for 1 hr. 100X.

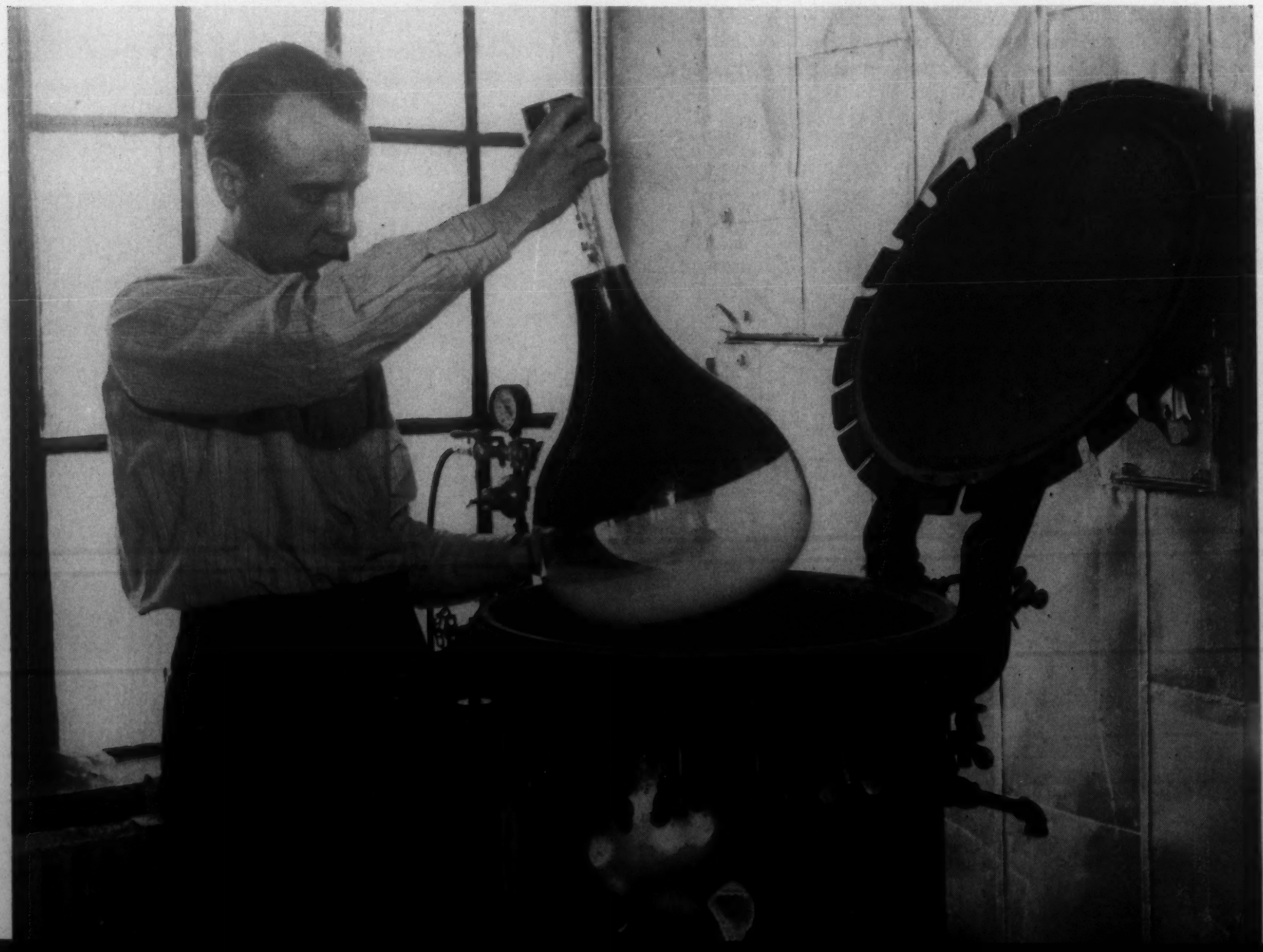
Fig. 19. Microstructure of Heat T 12808, annealed at 900 deg. C. for 1 hr. 100X.

ture of complete recrystallization rather than for an arbitrary single annealing temperature since at the former temperature little grain growth will have occurred. Actually, the hardness increase resulting from small amounts of these alloying elements in solid solution is quite small for annealed material. The base composition has a Vickers hardness of 76 while the hardest alloy (4.83 per cent Mn) is only 114.

Electrical Properties

The electrical resistivities at 20 and 100 deg. C. and the temperature coefficients over this range were determined on swaged and annealed wires about 0.1 in. in diameter and 20 in. long by measuring the drop across 18 in. of the specimen and across a standard 0.1 ohm resistor by means of a type "K" potentiometer. The current used was only about 0.5 ampere to prevent heating of the wires. The wires were immersed in a constant temperature oil bath, the temperature of which was measured to within 0.01 deg. C. When the resistivity is plotted against the temperature, a series of substantially parallel lines results, as shown by Fig. 20, the effect of alloying being primarily to displace the resistivities upwards; however, if the resistivity had been measured at several intermediate temperatures the resulting lines would be found to have a slightly increasing slope over this range.

In the manufacture of this cathode ray tube used in television, pure nickel is an important material.



If the resistivities were measured at higher temperatures, or included samples with larger amounts of alloying elements, more complicated relationships would exist due to the change in curvature in the vicinity of the Curie magnetic transformation temperature since the latter occurs at about 353 deg. C. in very pure nickel but is lowered by all additions with the exception of iron and cobalt.

The effect of alloying on the resistivity at 20 deg. C. can perhaps be better appreciated from Fig. 21. On a weight per cent basis the additions causing the greatest increase in resistivity are carbon, silicon, magnesium, manganese, copper and iron, in order of decreasing effect. In Fig. 22 the relationship between the resistivity at 20 deg. C. and the temperature coefficient over the range 20 to 100 deg. C. is shown. Some data for very pure electrolytic nickel are included in the same figure.

We hope that the above brief summary will be helpful to those concerned with the usual applications of wrought nickel. No attempt has been made to cover the numerous special purpose nickel alloys which find application because of their electrical, magnetic, or expansion properties. Many of these are essentially binary alloys of nickel and iron and their properties are described in detail in The Alloys of Iron Monograph series, "Alloys of Iron and Nickel" Vol. 1, by J. S. Marsh, to which the reader is referred.

While an attempt has been made to cite the origin of all data quoted, we want, particularly, to thank those who were kind enough to place information, some unpublished, at our disposal. In addition, we want to thank Lt. H. C. Pierson and W. R. Hempstead for their effective assistance in the prosecution of the laboratory work involved.

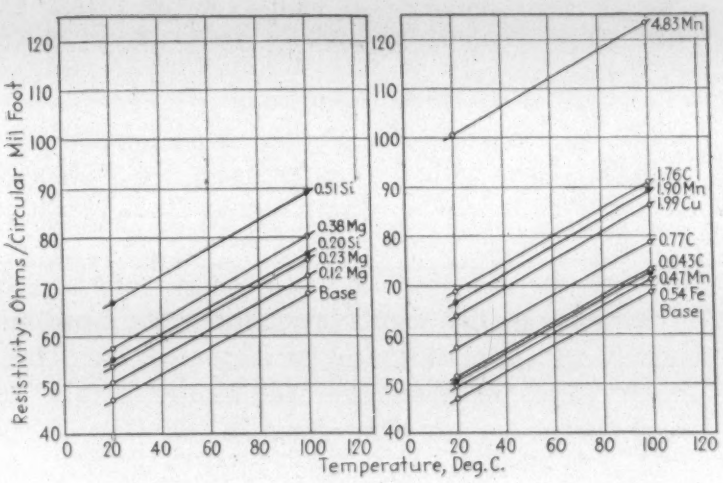


Fig. 20. Resistivity plotted against the temperature.

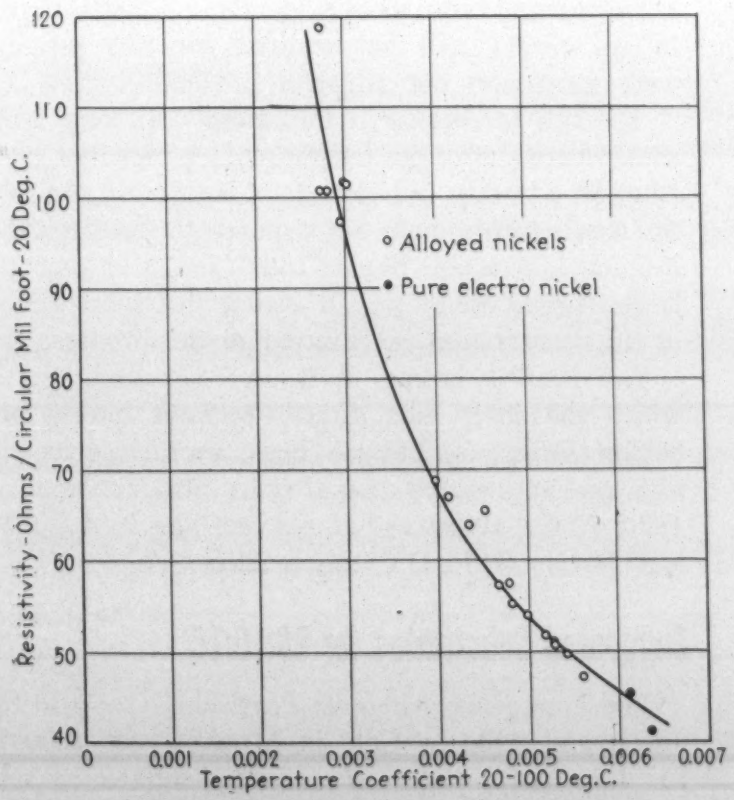
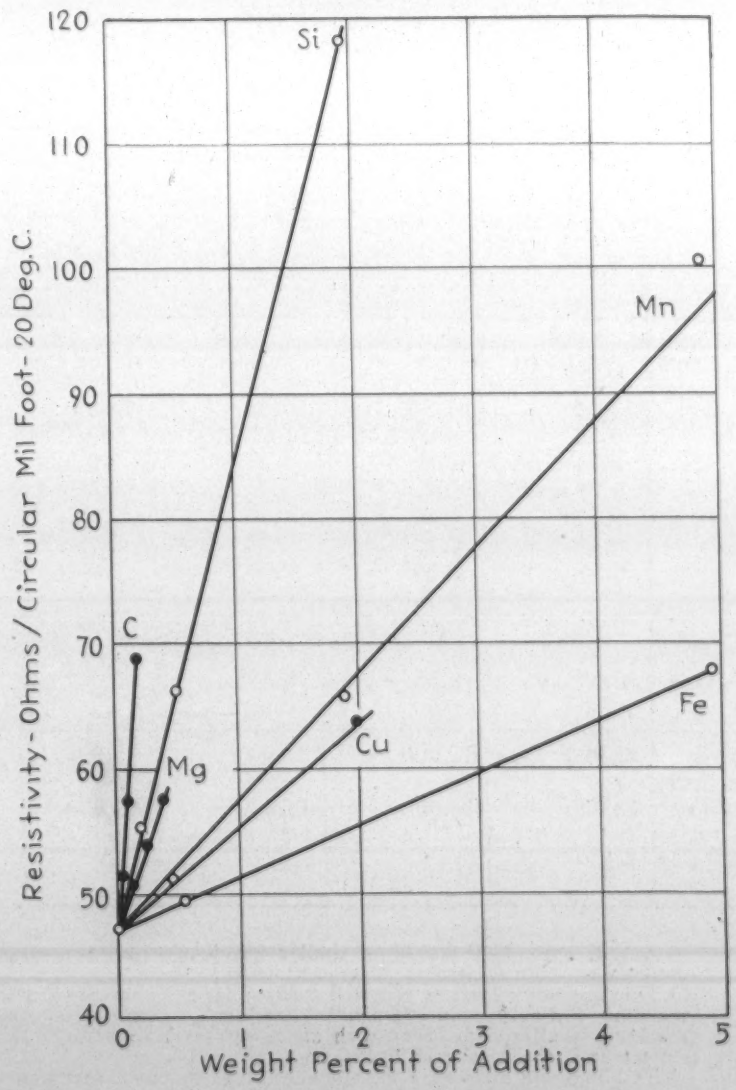


Fig. 22. Relationship between the resistivity at 20 deg. C. and the temperature coefficient over a range.

Fig. 21. Effect of alloying on the resistivity at 20 deg. C.



Substitutes for Leaded Bearing Bronze

A combination of drastic curtailment in the consumption of ultra-strategic tin for tin plate and solder on one hand and sharply increasing demand for bronze on the other bids fair to boost bronze into the No. 1 position among the single uses for tin. Conservation of the tin used in bronzes, therefore, becomes a project of major wartime significance.

The largest current application for tin bronze is for bearing bushings, and the most popular composition is the familiar 80 copper, 10 tin and 10 per cent lead alloy. Successful lower-tin substitutes for this leaded bronze can save thousands of tons of tin. This article reviews several possible substitutes and reports test data on the actual mechanical properties and relative bearing qualities of the most likely alternates. —*The Editors*

by R. W. DAYTON, H. W. GILLETT and L. E. BALCH

Battelle Memorial Institute, Columbus, Ohio

STATISTICS[1] ON THE USE of refined tin, exclusive of that contained in scrap, for the period October, 1940 to September, 1941, show for the four largest uses:

Use	*Long Tons*
Tin plate	44,000
Solder	17,000
Bronze	9,000
Babbitt	6,000

Substitution of electrolytic for hot-dipped tin plate, and use of this, and of lacquered, bonderized black plate for cans, will ultimately cut the tin requirement for tin plate down to less than 10,000 tons. Lead-tin solders are practically entirely substitutable by lead-silver solders. Lead-base babbitts can almost wholly replace tin-base. Silicon bronze will serve for most of the castings formerly made from tin-bronzes, but bronze bearing bushings remain on a tin-bronze basis. Some thousands of tons of tin would still be required for this purpose, were substitutes not adopted.

The call for bronze is increasing. In some Navy uses where corrosion resistance is paramount, substitution advances but slowly. Considering the total tin requirements, both for primary tin and for that contained in scrap, bronze bids fair to become the largest single use of tin. It is time that special effort in tin conservation be directed to the bronzes.

The bearing bronze most used for bushings, in which the shaft runs directly without having any babbitt lining, is, and has been, ever since its virtues were appreciated soon after its introduction about 1870, 80 Cu, 10 Sn, and 10 per cent Pb. In A.S.T.M. specification B144-41T, this is Alloy 3A.

Suggested Substitutes for 80:10:10

The Emergency Alternate Provisions [see also the article and table by Cole in METALS AND ALLOYS for July 1942, pages 67 and 68] suggest as substitutes for Alloy 3A, either Alloy 3B, or Alloy 3X or 3Y, the compositions of which are given in Table I.

Table I— Compositions and Properties of 80-10-10 and of the A.S.T.M. "Emergency Alternates."

Specified Items	3A 80-10-10	3B 83-7-7-3	3X[1] 80-7-10-3	3Y 84-8-8
Copper	77-81	81-85	77-81	82-85
Tin	9-11	6.25-7.50	6.00-7.50	7-9
Lead	8-11	6-8	8-11	7-9
Zinc	0.75 max.	2-4	2-4	0.75 max.
Nickel (max.)	0.50	0.50	0.50	1.00
Iron (max.)	0.15	0.20	0.20	0.15
Antimony (max.)	0.55	0.25[2]	0.75	—
Phosphorus (max.)	0.05	0.03	0.05	0.20-0.50
Other elements (max.)	0.35	0.35	0.35[3]	0.50[3]
Ten. str., lbs. per sq. in., min.	25,000	30,000	25,000	25,000
Yield str., lbs. per sq. in., min.	12,000	14,000	12,000	12,000
Elong. % in 2 in.	8	12	8	8

[1] A.A.R. spec. E-M-503-42 is similar but is a 83-7-9-1 nominal composition, Zinc limited to 2 per cent max.

[2] This antimony limit is reported to have been set on account of broaching difficulties in thin-walled bushings. Cracking during broaching is alleged to occur with antimony too high, though this is not true if the broach is kept sharp.

[3] No aluminum allowed, *i. e.*, not over 0.005 per cent determined on 10 g. sample. Silicon max.—0.003 per cent.

The analogous pre-war German composition D.I.N. No. 3 called for 7 to 9 Sn, 12 to 14 per cent Pb, 21,300 lbs. per sq. in., tensile, 8 per cent elongation. Kühnel[2] lists two commercial German leaded bronzes:

Cu	*Pb*	*Sn*	*Ni*	*Zn*
65	25	2	6	2
70	23	5	2	—

The 80:10:10 alloy consists of droplets of lead in a bronze matrix. The lead is there for its "lubricity," whether this be due to smearing of lead over the running surface to act somewhat like a very thin babbitt lining, to the ability of lead to hold a film of oil, or to the lead pockets wearing down to form tiny, oil-holding depressions. The weakening effect of the lead pockets makes the alloy distinctly softer than it would be without the lead, *i.e.,* it falls from 68 for the lead-free to 61 Brinell, with the 10 per cent Pb., according to Staples, et al.[3]

More than 10 per cent Pb adds somewhat to the "lubricity" but further softens the alloy and increases the difficulty of getting uniform lead distribution. As a rule, the more highly leaded bearing alloys utilize a softer matrix, *i.e.,* one of pure copper, of copper with a little silver, or copper with a very little tin. Such alloys are considered too soft to withstand high pressures, and compete more with babbitt linings or are applied in service slightly too severe for babbitt, rather than come into competition with solid, unlined 80:10:10 bushings. This classification may not be entirely justified, for more highly leaded alloys may be serviceable where 80:10:10 is used. At any rate, the 80:10:10 alloy now serves a large and important field of bushing applications.

Basic Requirements

The duty of the matrix is primarily to hold and support the lead droplets, and to strengthen the bearing sufficiently to maintain the necessary load-carrying ability (actually, the strength needed may be much below that of 80:10:10). The matrix must not be very prone to seizing or galling. Experience has shown that copper-tin bronze matrix is satisfactory for the purpose.

To save on material, a sintered 80:10:10 lining on a steel back may be substituted for a thicker solid bushing in some types of service. Even here, the replacement in whole or in part of the 10 per cent Sn in the lining, by some other element, would be distinctly in order.

The matrix is in the ratio of 89 Cu to 11 Sn. This composition is theoretically within the alpha solid solution field, but in the as-cast condition contains a small amount of a second phase, Cu_3Sn or delta, and shows marked coring. Compare micrographs shown by Staples, et al,[3]. Thus the matrix has hard particles or, at least, relatively hard localities in the cored structure.

Because of the inhomogeneity of the matrix structure, as well as the presence of the lead particles, neither the strength nor the ductility is high. The alloy often shows higher strength and ductility than the specification requirements, but a compressive yield strength, corresponding to the specified tensile yield strength, is obviously adequate and may be considerably more than is actually required for the service to which bushings of this alloy are put. Ductility itself is not utilized in bushing service and ductility seems to be specified merely as an indication that a particular lot of the alloy is a normal representative of its type.

Need for conservation of tin brings acutely to the fore the problem of making bushings with 10 per cent Pb, well distributed in a matrix of approximately the same yield strength and galling resistance as of the 89 Cu: 11 per cent Sn matrix, without using so much tin. In alloy 3B, the lead is at a lower level than in 3A, and the antimony is also held at a lower level. The properties of this alloy are compared with those of 3A by Harder and Cole.[4] Alloys 3X and 3Y are more comparable to 3A in lead content.

Alloy 3X replaced 3 per cent Sn by some 3 per cent Zn, but zinc only hardens approximately half as much per weight per cent as tin does; hence, the antimony is permitted to rise 0.20 per cent above the maximum alloyed in 3A, so that a more comparable degree of hardening can be obtained.

The specification for Alloy 3Y is silent on antimony, leaves out 2 per cent tin from the usual 10 per cent, but limits zinc to 0.75, and employs 0.20 to 0.50 per cent P as hardening element in lieu of the omitted tin.

The low antimony level in 3B and the low zinc levels in 3Y limit the feasibility of using scrap in their preparation without more knowledge of the composition of the scrap than is usually available. The reduction from 10 to 7 per cent Sn in 3X and from 10 to 8 per cent Sn in 3Y, are worthwhile reductions, but present conditions make it desirable that the only tin used be that from bronze scrap, or, if that level is unattainable, that as little as possible tin need be added. Cutting down to 7 per cent Sn is not a big enough cut.

Silicon Bronze and Aluminum Bronze

The necessity for lead at around the 10 per cent level seems to bar the substitution in bushings of aluminum bronze, manganese "bronze" (really brass), or silicon bronze, as the matrix to hold the lead. Silicon and aluminum, as every foundryman believes, are "inherently incompatible with lead," so these substitutions, adequate for a wide range of general castings formerly made in tin bronze, are not easily applicable to leaded bushings. Putting sufficient lead into these alloys may not be impossible, but it is not a simple task. Alloys of the manganese "bronze" type can be made without aluminum,

but the high zinc content of the manganese "bronze" type renders them too poorly resistant to seizure. High zinc brasses are admittedly unsatisfactory as bushings.

Hence, it is advisable to look to other alloying elements than aluminum or silicon as substitutes for some or all of the tin in 80:10:10, and to choose elements that are, first, available without necessity for overseas transportation, and, second, readily compatible with lead.

On these criteria, one could consider zinc, nickel, manganese, silver, antimony, arsenic and phosphorus. Many other calls for nickel make it not the most promising on the score of availability, but even so, a swap of nickel for tin may be a good one. The cost of silver, and a possible low degree of availability, renders it not the first choice from that aspect. Thus difficulty results not from actual shortage, but from political considerations relating to use of the Treasury stockpile for industrial purposes. This difficulty is becoming somewhat cleared up, but always hovers in the background.

Zinc and Nickel for Tin in Bronzes

Replacement of tin by zinc is technically limited by the poor bearing properties of copper alloys very high in zinc, so that it deserves attention more from the point of view of how much can be tolerated from the 85-5-5-5 and similar scrap which one would like to utilize for its tin content. In this connection, it may be remembered that by putting scrap through the Barrett cupola, nearly all the zinc can be driven off and nearly all the tin retained, so that when we are willing to sacrifice the zinc, the availability of 85-5-5-5 scrap for cases where we want the tin, but not the zinc, can be widened. In spite of all the evidence that, in lower lead bronzes, bearing properties are injured as tin is replaced by zinc, Staples, et al,[3] have indicated that this does not hold for 80:10:10. When 3.5 to 4.5 per cent zinc was added to 80:10:10, (the zinc content being subtracted from the copper content, *i.e.*, the copper was around 76 per cent), neither wear resistance, impact resistance, nor resistance to pounding was appreciably affected. Hence, a considerable tolerance for zinc in 80:10:10 is indicated. The mechanical test data reported by Harder and Cole[4] give a similar indication.

The substitution of 5 per cent Ni for 5 per cent Sn, making an alloy of 80 Cu, 5 Sn, 5 Ni, 10 per cent Pb, or 78 Cu, 5 Sn, 5 Ni, 2 Zn, 10 per cent Pb (for use as cast) has been suggested. Burgess and Woodward[5] in a Tin Conservation Symposium held during the previous war, cited the good properties of 88-10-2 in which half the tin was substituted by nickel, and Wise[6] further discussed copper-nickel-tin cast alloys, making the comment that lead behaves in these as it does in straight copper-tin alloys, though lead interferes with the ability of the alloys to be heat-treated. One or two per cent nickel is often added to the high lead copper-lead alloys for aid in distribution. If one were free to use nickel, the 3X type of alloy could be used, with nickel, say from Monel scrap, replacing perhaps half the tin, the other half coming from scrap. The structure of the matrix and the compatibility with lead render it probable that availability of nickel would permit worthwhile reduction in tin. However, there is not much direct evidence on large substitution.

Brinn[7] tried 81 Cu, 7 Sn, 2 Ni, 10 per cent Pb as substitute for 80:10:10 and found that the former had higher hardness and finer grain than the latter, but showed more wear. However, Staples, et al[3] found no notable differences in wear or impact resistance when a 2 per cent Ni addition was made to 80:10:10, but the addition increased the resistance to pounding.

Pilling and Kihlgren[8] added nickel to 80:10:10 but did not study substitution for tin. In discussion of this paper, St. John reported that "in an alloy containing 10 per cent Pb, the nickel had no tendency whatever to hold the lead in dispersion. We tried it over and over again, but if we let the tin drop below the critical point, the nickel did not hold the lead." The International Nickel Co.[9] states that tin may be advantageously replaced by nickel to the extent of 80 Cu, 10 Pb, 8 Sn, 2 per cent Ni instead of 80:10:10. This limitation was based on mechanical tests only. No tests were made to indicate bearing behavior.

Alloys of 5 to 6 per cent Sn, 1.5 to 2 per cent Ni with about 15 per cent Pb, and carrying phosphorus, have been marketed over a period of years for service for which 80:10:10 was previously used. One user of heavy duty bearings is substituting

Cu	*Sn*	*Zn*	*Pb*	*Ni*	*P*
76	6	1	16	1	0–0.05
85	3.5	5	5	1.5	0.005

for 80:10:10 in bushings.

It is also of interest as evidencing that a contaminated material may serve where a "pure" phosphor bronze has been used, that in service duty where 90 Cu, 10 per cent Sn (with up to 0.50 Ni and 1.00 per cent P) was formerly used, 88 Cu, 5.5 Sn, 4 Zn, 2.5 Ni, up to 0.50 Pb, up to 0.05 per cent P, has not only been satisfactory, but has out performed the phosphor bronze.

Phosphorus and Manganese Bronzes

"Phosphor bronze" is a familiar term among bearing metals. Although the phosphorus addition is generally small, merely sufficient to give the desired fluidity, there is a class of bearing bronzes to which phosphorus is added as a hardener, in

material amount. A.S.T.M. B66-38, for locomotive bearings, specifies 0.2 to 0.4 per cent P, with zinc limited to 0.5 per cent. Some railroad specifications read 0.7 to 1.0 per cent P. Clamer[10] cited, back in 1903, a standard railway phosphor bronze, 80:10:10 with around 0.80 to 1 per cent P. However, as Clamer[11] points out, the zinc content needs to be kept down when a material amount of phosphorus is added, which explains the zinc limit of Alloy 3Y.

Within the limits set by the residual zinc from scrap, phosphorus is a recognized hardener for replacement of some tin. Indeed, Slavinskiy, et al,[12] suggest 88 Cu, 2 P, 10 per cent Pb, *i.e.,* complete replacement.

The statement has been made[13] in reference to highly leaded bronzes, that "manganese can be used as an alternative to tin, since it is equally effective as a hardener." This stems from the work of Wecker and Nipper[14], whose work and comments were confined to alloys with 20 per cent or more lead. The file wrapper of Wecker's U. S. patent discloses suggestions for a tinless 30 per cent Pb alloy with 4 Mn, 3 Ni, 63 per cent Cu, or 5 Mn, 3 Sn, 62 per cent Cu, or 5 Mn, 2 Sn, 2 Ni, 61 per cent Cu; use of some antimony in conjunction with manganese nickel and tin is suggested, and a 20 per cent Pb alloy is mentioned with 3 Sb, 1 Mn, 3 Ni, 73 per cent Cu. Smiryagin[15] is cited as considering that manganese is a substitute for tin, the composition advocated for a leaded bronze being 7 to 8 per cent Mn, up to 30 per cent Pb, balance Cu. Clarke[16] mentioned replacement of some tin in leaded bronzes by nickel or manganese. Gleason[17] advocated 1.5 per cent Mn in a 65 Cu, 5 Sn, 35 per cent Pb alloy and also suggested that in a copper-tin-lead alloy, half the tin could be substituted by antimony.

Antimony for Tin

Clamer in the 1918 Symposium on Conservation of Tin says, "the first metal that presents itself as a substitute for tin (in leaded bronzes) is antimony." Car bearings with 30 per cent Pb, normally carrying 65 Cu, and 5 per cent Sn, were made with 3 Sn, 2 Sb, 2 Sn, 3 Sb, and 5 per cent Sb with no tin. Strength increases and ductility falls with increase in antimony. For a period during the last war a copper-antimony-lead alloy was sold as a substitute for 80:10:10, but the alloy was apparently abandoned. A customer of the Ajax Metal Co. ordered 500 lbs. of an alloy of 84 Cu, 11 Pb, 3 Sn, 2 per cent Sb, and pricing authority had to be obtained, which was finally given by O.P.A.,[18] But by that time the customer had cancelled the order! Nevertheless, the alloy seems to deserve consideration.

Some of the antimony would be expected to go to the lead and produce harder globules. However, antimonial lead babbitts are well known, and no harm is likely to be done by this hardening. Staples, et al,[3] added 1 per cent Sb to various bronzes, including the 80:10:10 type, and found that it increased the resistance to pounding, slightly increased wear resistance, and decreased the impact resistance. Unfortunately, in this study as in many others, when another hardening element was added, the tin content was kept at its regular level, so that the effect studied was that of addition, not substitution.

It is reported[18] that the Hamilton Gear and Machine Co. of Toronto, Canada, finds an alloy of about 90 Cu, 8 Sb, 2 per cent Ni satisfactory for worm gear service, but that the proper antimony content still requires study.

There is so great a similarity between the copper-tin and the copper-antimony equilibrium diagrams, that this substitution is very interesting from the metallurgical viewpoint. Moreover, the hardening effect upon the alpha solid solution with copper is shown by Brick, Martin and Angier[20] to be almost identical. Gardner and Saeger[21] examined the effect of antimony in red brass only up to 0.25 per cent. Smith and Bolton[22] extended this to 0.55 per cent Sb, in an alloy with 88 Cu, 6 Sn, 4 Zn, 1.5 per cent Pb, finding no appreciable detriment so long as the sum of sulphur plus antimony did not rise too high. The tolerance for sulphur and antimony together was indicated as 0.15 per cent S plus 0.30 per cent Sb. However, one lot with 0.133 per cent S and 0.53 per cent Sb gave acceptable properties.

These investigations relate to mechanical properties, not to bearing behavior. Straight copper-antimony and copper-manganese bronzes for corrosion resistance have been discussed by Pershke and Vasvutovich.[23] Up to 7 per cent Mn or about 5 per cent Sb gives an alpha solid solution. The antimony bronze is reported as of poorer mechanical properties and slightly poorer corrosion resistance against H_2SO_4, than tin bronze.

Arsenic and Silver in Bronzes

Arsenic is a hardener for lead, as is evidenced in bird-shot, and its effect in gun metal with 2 per cent Pb, has been studied by Rolfe,[24] and cited by Gregg.[25] Much work has been done on wrought arsenical copper, little on castings. In the bronze castings, small amounts of arsenic were reported as beneficial to fluidity, but with relatively large amounts, ductility was reduced, and strength slightly reduced.

Dudley[26] reported 50 years ago that either 0.80 per cent P or 0.80 per cent As in 80:10:10 behaved about the same as bearings. Heyn and Bauer[27] studied 85 Cu, 15 Sn, with up to 1.5 per cent As, finding that the addition induced porosity. Bassett[28] concludes that antimony will do all that arsenic will do without the disadvantages of arsenic, but

thinks that the antimony should be limited to 2 per cent in leaded bronzes. Some authorities consider that arsenic produces lead sweat in alloys of 15 per cent or more Pb.

About 8 per cent Ag is soluble in copper at elevated temperatures. The silver is thrown out of solution on cooling. A per cent or so of silver is often used in the highly leaded copper-lead alloys, indicating compatibility. Setapen[29] states, "silver can be partially substituted for tin in the higher tin bronzes without much change in properties." The presence of 3 per cent Ag in wrought bronzes of 5 to 10 per cent Sn makes them capable of precipitation hardening.

Chromium, Copper and Lead

Miller[30] rather vaguely refers to rolling mill bearing bronzes containing chromium, stating in one place that the alloys contain 2 to 10 per cent Sn with 1 per cent or more each of chromium and iron, and in another that "the bearings contain a chromium-rich constituent in addition to the usual alpha and delta phases," a condition that would not be met if much tin had been substituted for. The difficulties of getting chromium and iron into solution in the melt and in controlling their distribution in the casting would appear sufficient to make the substitution of tin by ferrochromium a last resort.

If a lower copper:tin ratio in the matrix would produce a bushing that would operate just as well, one might say that in such an alloy copper was being used as a substitute for tin. Etchells and Underwood[31] remark that "bearings designed for static loads must, of necessity, carry low pressure, else they will be hard to start. Depending on the temperature at the time, the torque required to start plain bearings, under load, may be as much as 10 or 20 times the starting torque. General practice indicates that the unit load should be on the order of 250 to 300 lbs. per sq. in. for starting purposes under load, unless some external means is applied to release the metal to metal contact, such as feeding high pressure oil on the loaded side to lift the journal."

They point out that an alloy of 72 Cu, 3 Sn, 25 per cent Pb (matrix ratio 96:4), in operation, will stand 3,000 to 4,000 lbs. per sq. in. projected area when operating at 300 deg. F., and one of 55 Cu, 45 per cent Pb will stand 2,000 to 3,000 lbs.

If a more highly leaded alloy than 80:10:10 will serve, because the starting limitations hold the possible load well within its ability to resist deformation, then a bushing whose volume includes more lead, requires less tin, and lead thus becomes a substitute for tin.

Experimental Work

The evaluation of bearing metal by laboratory tests is a tough job. Standard tensile test bars do not have cooling rates comparable to those of the ordinary bushings, nor does bearing service directly involve the strength and ductility properties evaluated by the tensile test. Aside from resistance to deformation under compression, measurable directly by static test or by repeated pounding tests, or indirectly through the tensile yield strength, or through hardness, the important feature in a bushing alloy is resistance to galling under starved lubrication. Some appraisal of galling behavior may be had by laboratory tests, but the behavior in respect to clearance between shaft and bushing, to hardness of the shaft, and to finish of both shaft and bushing, is not at all to be evaluated without actual operation as a bushing, and not thoroughly evaluated save in widespread and long continued service.

Nevertheless, fairly simple laboratory tests, made in comparison with conventional alloys, can be trusted to sort out those alloys quite unserviceable and leave, as worthy of practical service trials, those whose behavior in the laboratory reasonably approximate that of the time-tried alloy for which substitution is sought.

Tensile, hardness and Amsler seizure tests were made on alloys of several types and the best selected for further study. Many other alloys were rejected for a variety of reasons.

An alloy of 83 Cu, 10 Pb, 5 Mn and 2 per cent Sb was discarded because sound castings were not readily made. Other alloys consisting of combinations of manganese and phosphorus or antimony with 10 per cent Pb, balance copper, such as 10 Mn-0.4 P, 5 Mn-0.6 P, 5 Mn-0.8 P, 10 Mn-1 Sb and 5 Mn-1.5 per cent Sb, were all brittle and unsound. An alloy containing 80 Cu, 10 Pb, 8 Sb and 2 per cent Ni was hard, brittle and weak. An alloy in which there was total replacement of tin by manganese had interesting properties, but was more difficult to handle in the foundry than some of the other alloys. Combinations of manganese and tin were not wholly desirable for the same reason.

Alloys of copper-lead-tin-zinc and manganese; copper-lead-tin and antimony with or without zinc as an "impurity," copper-lead-silver and phosphorus and copper-lead all had desirable properties in one respect or another and were chosen for more intensive study.

Compositions Selected

The selected compositions follow:

(1) 80 Cu, 10 Pb, 2.5 Sn, 2.5 Zn, 5 per cent Mn:

This alloy can be made from 85-5-5-5 scrap by adding copper, lead and manganese. Electrolytic manganese might be considered a prerequisite, if it were proven that the aluminum and silicon of ordinary manganese are too high for compatability with lead in ordinary foundry practice. However, in this work cupro-manganese containing 30 per cent Mn and 0.66 per cent Si or thermal manganese con-

taining 99 Mn, 0.6 Si, 0.4 per cent Al were used interchangeably without any adverse effects attributable to the aluminum or silicon.

Sound castings could be made with this alloy as readily as with 80 Cu, 10 Sn, 10 per cent Pb, so it is expected there would be no unusual production difficulties from porosity.

(2) 85 Cu, 10 Pb, 3 Sn, 2 per cent Sb and 85 Cu, 10 Pb, 3 Sn, 2 Sb, 0.28 per cent Zn:

A set of test bars of this alloy showed it to be quite promising, so it was included in the study. From the point of view of substitution, this is a good alloy, since it can be made from scrap of several kinds—for instance, by removal of the zinc from 85-5-5-5 and use of such scrap with scrap copper, antimonial lead and babbitt additions. Since it was found that zinc can be tolerated in this alloy, 85-5-5-5 scrap can be used without complete removal of its zinc.

(3) 84 Cu, 10 Pb, 5 Ag, 1 per cent P:

Combinations of silver and phosphorus were found to confer some hardening on the matrix though an alloy of the above composition was much softer than 80 Cu, 10 Sn, 10 per cent Pb. Nevertheless, since these bearing alloys are used at loads which are limited by their bearing properties rather than their strength, and since the bearing properties of this alloy were highly attractive, further study was devoted to an alloy of this composition.

(4) 90 Cu, 10 per cent Pb:

Though weak, it seemed that this alloy merited further study for the same reasons as the one just discussed. (An alloy of 87 Cu, 10 Pb, 3 per cent P was also made up but has not yet been tested exhaustively, since it was not much harder than the 90 Cu, 10 per cent Pb).

The alloys for heats of these compositions, and of 80 Cu, 10 Pb, 10 per cent Sn, which was used as a standard, were prepared from virgin metals, melted in an induction furnace in a clay-graphite crucible. Since it was found helpful to use the equivalent of an ingoting process to remove gas, the alloys once melted and mixed were allowed to freeze in the furnace, then remelted and poured. Both green and dried sand molds were used, with no apparent differences in the castings.

Double keel blocks were cast for tensile bars, which were machined to standard dimensions. The same castings also were used for 1 cm. diam., 2 cm. long pounding and compression specimens. The tensile properties were obtained in the usual manner, with yield strength determined for a 0.2 per cent offset. Compression tests were made at both room temperature and at 300 deg. F., by applying a predetermined load to the specimen and then measuring the amount of deformation. Pounding tests were made at room temperature and at 300 deg. F. in a Bureau of Standards type pounding test machine.

Bearing Test Results

Three different types of bearing tests were run. One was an Amsler seizure test whose details have previously been described.[32] In this test a partial, fitted bearing 0.25 in. long and 0.15 in. wide is run against a 2-in. diameter steel shaft whose hardness was 42 Rockwell C. The load required to cause a particular coefficient of friction is called the seizure load.

A wearing-in test has been developed and used in the present work. This was done because the seizure tests showed that some bearings wore in more readily than others and it was thought this property might be significant in the use of such bearings. The Amsler machine was also used for these tests, against a shaft of the same diameter. The bearing was a plane, fine ground surface, 0.15 in. wide.

The first step in the wearing-in tests was to heat the assembly to 250 deg. F., the test temperature, then to apply a load of 132 lbs. between the bearing and shaft, and then to start the machine. In about an hour, the shaft wore a seat in the bearing, and the friction dropped to a value which did not change appreciably during further running. Once this fact was understood, all future tests were run for 1 hr. The extent of wearing-in was reported as the final coefficient of friction, for it was thought that the reduction of friction was the most significant factor in wearing-in.

Sleeve-bearing tests also were run. Proper oil grooving and pressure oil feed are important in securing consistent results in such tests. In the test which was finally adopted, a 1-in. bore, 1-in. long bearing was pressed into a steel shell and tested against a steel shaft (Hardness *36* Rockwell C) with a clearance of 0.003 in. Lubricant at 5 lbs. per sq. in. was supplied to an axial oil groove $\frac{1}{8}$ in. wide and $\frac{7}{8}$ in. long in the unloaded portion of the bearing. The shaft was driven at 1,750 r.p.m. by a $\frac{1}{4}$-hp. motor which would deliver a 50 per cent overload before stalling. The bearing was finished by fine boring with a carbide tool. The shaft was finely ground and then lightly polished with 4/o emery paper.

The first part of the test was a wearing-in period, in which the bearing was run at 60-lb. load for 15 hrs., to warm up the bearing to its normal operating condition. At this time, its temperature usually rose to 40 deg. F. above room temperature. Load was then applied to the bearing in the following stages—100-200-300-500-700-1,000 lbs. and so on—in increments of 500 lbs. until complete seizure occurred. Two or more duplicate tests were run.

The test results for the five substitute alloys appear in Table II. In mechanical properties, the closest substitute for 80:10:10 is Alloy A containing 80 Cu, 10 Pb, 2.5 Sn, 2.5 Zn, 5 per cent Mn. The next closest substitute is Alloy B containing 85 Cu, 10 Pb, 3 Sn, 2 per cent Mn, which is only slightly softer than 80:10:10.

Alloy E containing 90 Cu, 10 per cent Pb and

Table II.—Properties of Substitutes for 80-10-10 Bronze

Alloy	Composition, Per Cent								Tensile Properties				Brinell Hardness
	Cu	Pb	Sn	Mn	Zn	Sb	Ag	P	Yield Strength Lbs. Per Sq. In.	Tensile Strength Lbs. Per Sq. In.	Elongation, Per Cent	Reduction of Area, Per Cent	
	80	10	10						17,500	36,600	19	21	62
A	80	10	2.5	5	2.5				15,800	29,200	12	16	61
B	85	10	2.8			2.09			14,300	30,100	18	17	51
C**		10	2.8		0.28	2.05			13,600	27,800	18	17	47
D	84	10					5	1	8,900	19,500	10	11	40
E	90	10							6,100	9,800	5	4	23

** Same as B, but made with zinc-containing scrap.

Alloy D containing 84 Cu, 10 Pb, 5 Ag, and 1 per cent P are considerably softer and weaker than 80:10:10, nevertheless, they might well be considered as substitutes because of their excellent bearing properties. We doubt the types of bushings for which substitutes for 80:10:10 are being sought are frequently used where the weakness of these alloys would be a handicap.

In bearing performance, the 90 Cu, 10 per cent Pb, and 84 Cu, 10 Pb, 5 Ag, 1 per cent P alloys just mentioned, are excellent, much better than 80:10:10. The 85 Cu, 10 Pb, 3 Sn, 2 per cent Sb alloy is an almost identical substitute for 80:10:10. The presence of zinc has no effect on seizure resistance, though it decreases the ease of wearing-in. The 80 Cu, 10 Pb, 2.5 Sn, 2.5 Zn, 5 per cent Mn alloy is less seizure resistant than 80:10:10 and wears in less readily, but it is not believed that the difference will affect ordinary bearing performance.

Recapitulation

Any of the alloys described seem to have properties sufficiently good to permit the substitution of one or another in almost any present use of 80:10:10. All of them are described, for the momentary availability of scrap shifts so that it is well to have several strings to one's bow. Scrap copper is not readily available, though some may have to be provided whatever the alloy used, if bushings are to be made from anything but 80:10:10 scrap, or Scrap 3B, 3X or 3Y where those are applicable. Scrap composition red brass is rapidly disappearing. Use of Monel scrap has been so greatly restricted by official orders that an idle supply has been built up, but it is not easy to get a release on it, and electrolytic manganese is in scanty supply, so either a nickel or manganese substitution would be beset with difficulty if electrolytic manganese is considered essential. The antimony substitution is the one least beset with difficulties of this sort.

Actually, even an appreciable reduction in tin content of alloys in which primary tin has to be used on account of specifications that limit impurity contents so severely that scrap cannot be employed, is less helpful than the complete elimination of primary tin by utilization of the tin content of secondary sources of supply.

The antimony substitution appears, from the laboratory tests, to have possibilities for equaling the behavior of 80:10:10 as a bushing. It appears to have an adequate tolerance for zinc to permit its production from 85-5-5-5 scrap from which part of the zinc has been removed in the Barrett cupola.

The 80 Cu, 10 Pb, 2.5 Sn, 2.5 Zn, 5 per cent Mn alloy appears to be a suitable substitution which can be made from 85-5-5-5 scrap, copper, lead and manganese.

The usefulness of straight 90 Cu, 10 per cent Pb seems great. Though it would appear at first sight that pure metals might be required for its manufacture, it is suggested that since 90 Cu, 10 per cent Pb has better bearing properties than 80 Cu, 10 Pb, 10 per cent Sn, the alloys of intermediate tin content will have intermediate bearing properties. Accordingly, any alloys of copper and 10 per cent Pb, with 0 to 10 per cent Sn, and the ordinary impurities, should often be usable as a substitute for 80:10:10. Such alloys can be made from almost any bronze scrap.

The 84 Cu, 10 Pb, 5 Ag, 1 per cent P alloy is a possible, but not a likely substitute. Alloys B, C and some composition between 80:10:10 and E are the substitutes which merit most attention. Technically, it would appear from among them an alloy can be chosen to fit all needs for 80:10:10.

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Table II.—(Continued)

Alloy	Compressive Stress to Cause 10 per cent Deformation—Lbs. Per Sq. In.		Per cent Deformation in 1,000 Blows of Pounding Test		Amsler Seizure Load-Lb. Per Sq. In.	Coefficient of Friction at End of Wear-In Test	Seizure Pressure in Sleeve Bearing Tests Lbs. Per Sq. In.
	Room Temp.	300 deg. F.	Room Temp.	300 deg. F.			
	43,000	40,000	2.3	2.0	5,000	0.007	4,000
A	34,000*	36,000	4.7	5.4	3,300	0.015	2,500-4,000
B	31,500	28,000	8.4	8.7	5,300	0.011	3,500-4,000
C**	33,500	27,000	5.8	6.2	5,300	0.018	3,500-5,000
D	—	—	—	—	6,000	0.002	—
E	—	—	—	—	10,000	0.002	—

* Specimens showed evidence of porosity during testing.
** Same as B, but made with zinc-containing scrap.

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Radiography of Spot Welds—II

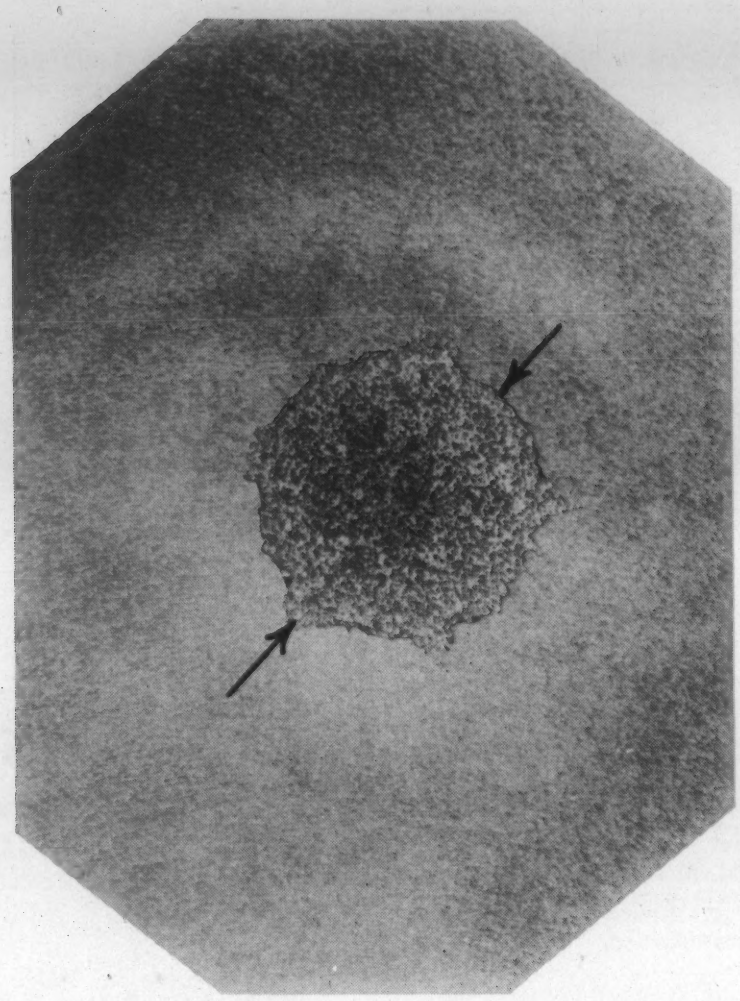


Fig. 1. Photomacrograph of an irregularly shaped nugget. Etchant: Kellers. 5X.

by ROBERT C. WOODS, JOHN C. BARRETT and T. W. DIETZ

Director of Research, Metallurgist and Research Engineer, Respectively, The Taylor-Winfield Corp., Warren, Ohio

Test methods, because of their natural influence on specifications, are of interest to design engineers as well as men concerned primarily with production or inspection. The first section of this 2-part article (METALS AND ALLOYS *for September, page 442) discussed the use of radiography for indicating spot-weld "quality." In this instalment various practical factors to be considered when actually making the radiographic inspection are outlined. —The Editors*

IN THE PRECEDING SECTION of this discussion the various radiographic rings around the peripheries of spot welds were described and their significance as barometers of weld-quality was set forth. The conclusions drawn were that neither the size, shape, nor density of these rings could, in general, safely be used as indications of weld fusion or strength.

The welding inspector or plant engineer, to whom these articles are largely addressed, is very little interested in the academic and more abstruse aspects of spot welds, regardless of how fascinating such a study may be to the research worker. The primary question in the mind of the application engineer, especially in the aircraft industry, is—"Will it ever be possible non-destructively to tell a good spot weld from a bad one?" At least to those concerned with aluminum alloy welding, the answer now is "Yes."

It has been stated by numerous competent workers, and it has been the experience of the authors, that the size and penetration of the fused weld nugget is a fairly good indication of spot weld strength. A combination of radiographic techniques is about to be described which has given in this laboratory satisfactory determinations of both dimensions.

How The Radiographs Are Made

First, perhaps, a brief description of the radiographic technique routinely used should be given.

There still appears to be prevalent a considerable amount of loose talk and over-emphasis relative to the radiographic factors of X-ray tube target size and target-to-film distances. As has been explained most fully in the literature, when dealing with relatively thin specimens, simple geometry shows these arguments to be rather flaccid.

It may upset some radiographers to learn that here, and elsewhere, routine spot weld examination on materials up to 0.125 in. total thickness is being carried out quite satisfactorily with target-film distances of from 9 to 18 in. If the target size and material thickness are known, the unsharpness in the resulting radiograph can be readily calculated by resorting to the formula $u = ft./(d\text{-}t)$ where f is the diameter of the focal spot, t is the thickness of the spot weld and d is the target-film distance; u then is the fuzziness of a defect.

The answer will usually be expressed in a few ten thousandths of an inch, less than the eye can detect. There are, of course, other factors affecting radiographic unsharpness, but these are not pertinent to this argument and so may be disregarded. Voltage applied across the X-ray tube and type of film used are much more vital factors than target size and distance. Lowering of voltage is accompanied by lengthening of emitted radiation wave lengths and an increase in radiographic contrast, which is much to be desired. Since X-rays obey the same inverse square law as light, the advantages to be gained through shortening of target-film distances become of considerable practical importance.

For example, an X-ray tube operating at, say, 25 kilovolts produces with a 5-min. exposure only a faintly discernible image of a given spot weld set up 36 in. away. But if the weld and film are moved up to an 18-in. distance, the result is the same as though the exposure time had been quadrupled. Had the distance not been decreased, a satisfactorily dense film could not have been obtained at the 5-min. exposure without raising the kilovoltage and thereby losing contrast.

Selecting a Film

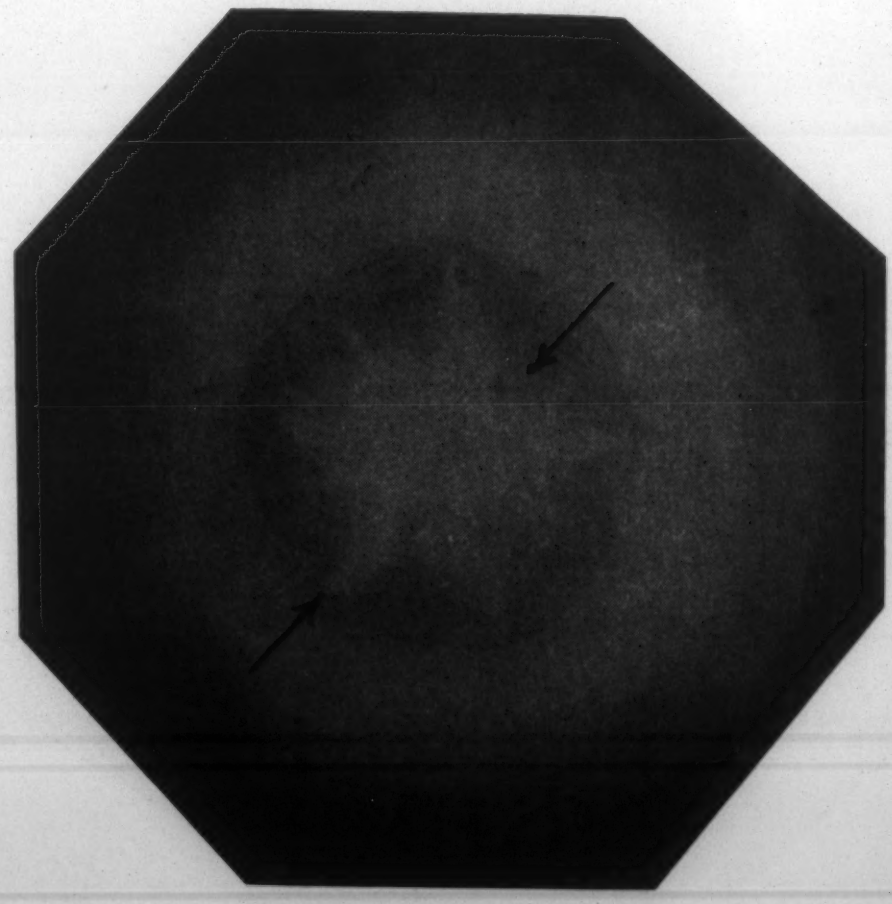
As to the type of film used to record the spot weld image, the choice may rest largely with the worker. However, there is no denying that none of the more commonly used X-ray films now on the market is entirely satisfactory. This laboratory routinely employs Eastman Process Orthochromatic film because of its relatively high contrast combined with fine grain for study of detail. Needless to say, it is slower than X-ray film. Recently a new radiographic film Eastman Type M, has been tried and found vastly superior to anything used heretofore. [Other film companies have also recently introduced new and improved types of radiographic films.—Editors.] These factors of contrast and grain size are extremely important, as those radiographers know who have not confined their studies to X-rays alone, but have also considered the characteristics of photographic emulsions.

Turning back to the spot weld itself, reference to Fig. 1 shows a photomacrograph ar 5x of an aluminum alloy spot weld with a highly irregular fused nugget. Comparison of this picture with the radiograph (also enlarged to 5x) in Fig. 2 shows the same star shaped outline. That the outlines seen in both faithfully correspond is borne out by careful measurement, not only on this specimen but on scores of others.

In Fig. 3 there appears an aluminum alloy spot weld also sectioned parallel to the face of the sheet. Arrows AA indicate the extent of fusion. In the enlarged radiograph, Fig. 4, of the same weld, arrows AA likewise indicate the fused line of demarcation which lies immediately inside the dark eutectic poor circular area on the X-ray negative. That is, it is not the inner area of the dark ring itself which must be measured, but a zone inside it where there occurs a sudden change in photographic density. This sudden change does not necessarily take shape as a ring, but follows exactly the contours of the nugget, as in Fig. 2.

The authors readily admit the difficulty of demonstrating by printed word the exact location of fusion

Fig. 2. Radiograph of specimen shown in Fig. 1. 5X.



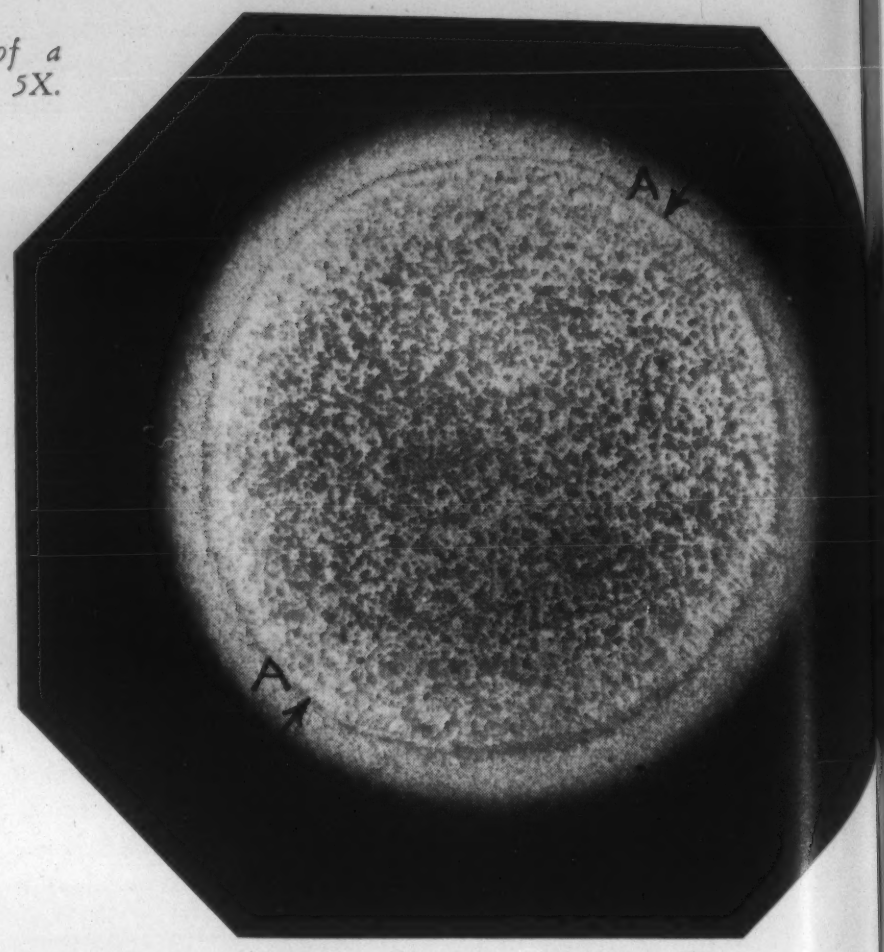


Fig. 3. Nugget shape of a good weld. Etchant:Kellers. 5X.

zone limits when it will vary from weld to weld in its position and form relative to other more constant landmarks. Nor will this description immediately enable a tyro to scan a spot weld radiograph and pick out the nugget outline. It undoubtedly requires practice, but so does the correct interpretation of any scientific or engineering record. The important point is this: The markings are there, and they can be seen easily without magnification of the image.

Checking Weld Nugget Thickness

The method for comparative determination of the weld nugget thickness in dimensions vertical to the plane of the sheet is slightly more complicated than simple viewing of films, but there is no good reason why any worker who becomes adept at it, should not make the system a practical one. Because to date, the technique has only been proven on 24 ST Alclad aluminum sheet welds, no broad claims are made. The method may, however, be a start in the right direction and it is hoped that further work will put it on a more widely practical basis.

As brought out in the previous section, when X-rays of a given wave length traverse any piece of matter, they are impeded according to a formula which takes into account the composition, atomic weight, and specific gravity of the material. Logically, then, this must also include places in the material where outright voids occur or where the crystalline packing is not as dense as in neighboring zones. This also applies to areas where certain constituents in an alloy may have left that section and migrated to some other location.

Where these conditions exist, X-rays penetrate with greater or less ease depending upon the nature of the material through which they pass. When a photographic film is properly placed, it will produce a visible image of these varying conditions. That is, wherever X-rays are permitted to pass in abundance, the silver halide emulsion undergoes a photochemical change which is developable into patches of black silver grains. But wherever X-rays are partially impeded or absorbed, fewer halide grains are affected and thus less film blackening occurs.

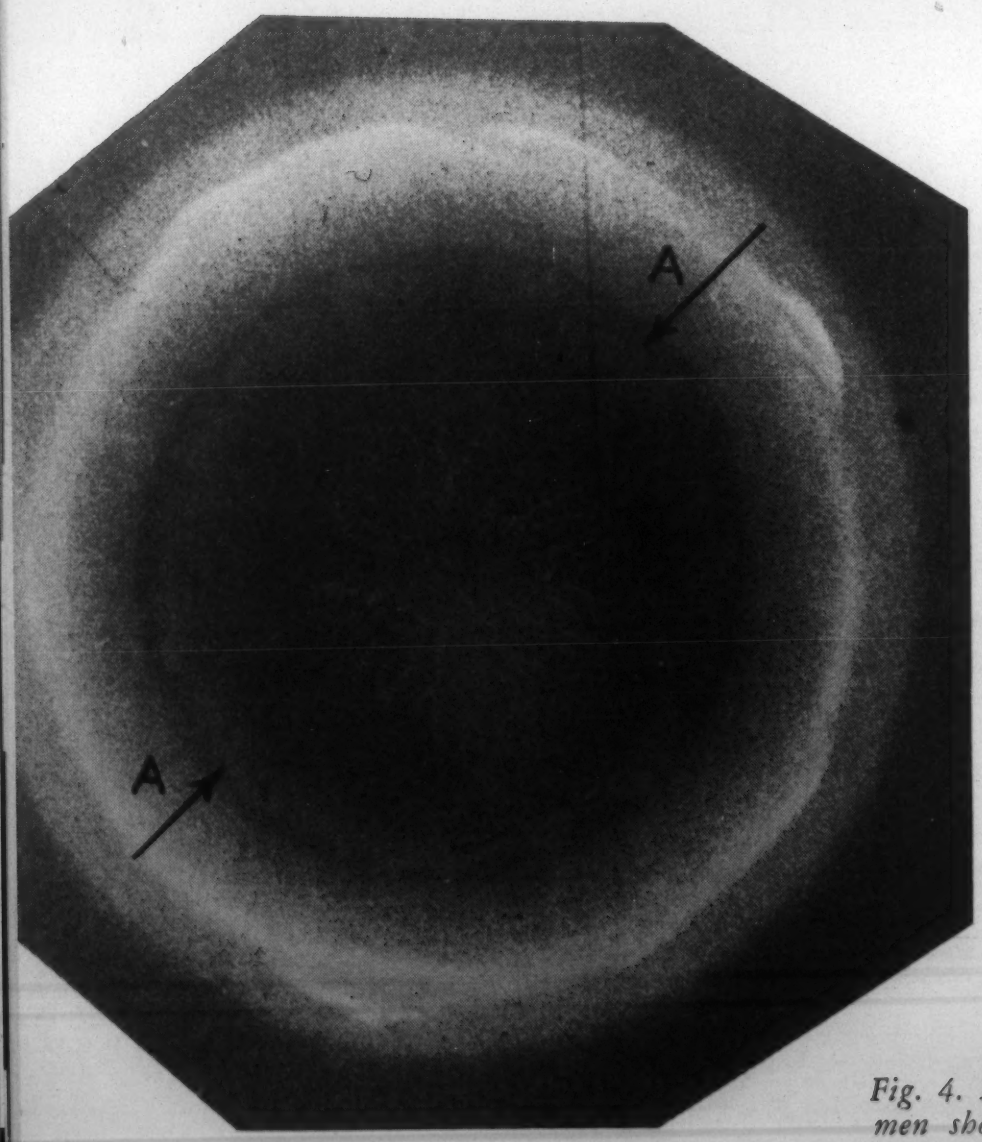


Fig. 4. Radiograph of specimen shown in Fig. 3. 5X.

Densities Measured Automatically

The human eye is an excellent device for viewing a completed radiograph in its entirety or even at one small point at a time. However, the eye has little quantitative memory for fine gradations of brightness between two or more points viewed singly. Fortunately, in the optical densitometer we have an instrument which corrects this deficiency in the field of photographic films. Briefly, the densitometer permits accurate measurement of photographic densities by measuring the light transmission from point to point through any film under examination. The readings obtained are equal to the logarithm of (1/transmission) which is merely a convenient way of expressing the light-stopping power of the radiographic image on the film.

It was hoped that through densitometer measurements of spot weld radiographs, coupled with metallurgical sections, some useful data might be compiled. Accordingly, a series of welds was made using various welding machine settings so that the energy varied and thus changed the size of the weld nuggets. The completed samples were radiographed in such a way that no variations in radiographic technique or dark room procedure would affect the over-all results. Surface indentation, as it affected X-ray absorption, was also taken into account by using finished specimens of equal thickness.

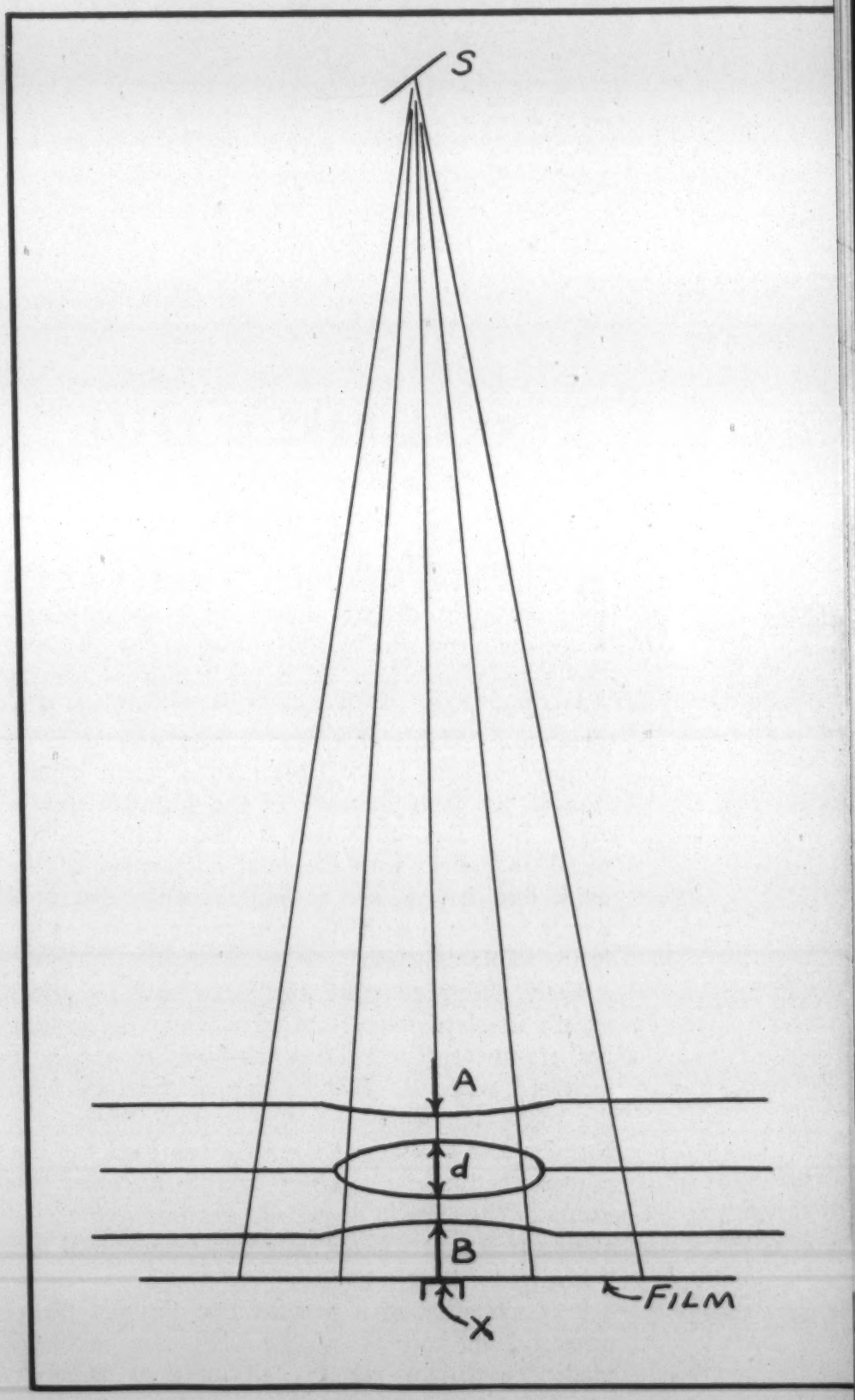
Densitometer readings were then taken on the radiographs at point X, as in Fig. 5. It was found that as the weld thickness increased (dimension d, Fig. 5), photographic density also increased. That is, as the space between A and B becomes more and more filled by weld metal, the X-ray absorption goes down. Or to put it another way, spot weld metal is less dense to X-rays than is the base metal. This, perhaps, is to be expected, because the weld material is cast in structure, even though it has been cast under high pressure.

The reason for the decreased X-ray absorption in cast structures as compared to rolled metal is not yet clear. In a previous experiment, one of the authors found this same disparity to exist between otherwise similar samples of rolled and cast metals with like specific gravities. It is possible that the alignment of crystals relative to the direction of radiation travel may enter into the picture. In the 24 ST Alclad spot weld, increased migration of a copper-bearing eutectic away from the center with increased energy input may also be a factor to consider.

It is not desired to convey the idea that, at the moment, densitometer measurements will give quantitative data. It is not yet possible to say, for instance, that weld A has a penetration of 1, and weld B, 1.5. The results now are mostly potential, and comparative, and they can only be expressed as follows: In 24 ST Alclad spot welds, it is possible to determine whether one weld nugget is thicker or thinner than a previously selected standard, *other factors being equal.*

In conclusion, the authors wish to confess to the realization that they have but made a start toward solution of the spot weld radiographic inspection problem. It is their hope that other workers, more able or more favorably situated, will speedily bring this work to a satisfactory close.

Fig. 5. How densitometer readings of radiographs were taken.



Plating on Aluminum

The potential design advantages of electro-plated metals with aluminum as the basis material have long been apparent to engineers. Electroplates on aluminum would provide a combination of aluminum's lightness or conductivity with the plate-metal's corrosion-resistance or wearing qualities, for example, but practical problems associated with the plating operation—particularly that of achieving satisfactory adhesion—have in the past been prohibitively great. Now, however, other metals are being commercially plated on aluminum, by a method and with results that are described in this article. Some of the interesting applications of the plated combinations thus made available are also reviewed.

—The Editors

by RAYMOND F. YATES

President, Krome-Alume, Inc., Lockport, N. Y.

PRIOR TO THE APPEARANCE of the Krome-Alume process for plating aluminum, would-be-platers of the metal and its alloys struggled to eliminate the ever-present film of oxide which is quickly formed on fresh aluminum surfaces at ordinary temperatures. While this film is extremely thin, its nature was such as to prevent an adherent deposition of the large majority of the plateable metals. Aside from this, aluminum is also a rather passive metal and, even with the total elimination of the oxide film, it presented plating properties that stubbornly interfered with efforts to produce commercially-acceptable adhesion.

Early efforts to plate the metal and its alloys usually involved some form of etching. Subsequent heat treatment of nickel deposits have brought about increased adhesion. The etching of the surface of the metal not only destroyed surface smoothness but was also costly and the solutions used for the purpose had to be selective and based upon the nature of the alloy to be plated. For this reason preplating treatment was not only somewhat critical but it involved a large number of cycles and was costly.

It is somewhat of a paradox that the first really successful method of plating aluminum involved anodic formations whereas all previous attempts sought to eliminate all traces of oxide.

In the Travers' Krome-Alume method, anodic oxidation after cleaning is the primary step. Curiously enough the more perfect the anodic coat, the greater is the adhesion established. It follows, therefore, that maximum adhesion will be had with the purer forms of aluminum like alloys 2S and 3S. Here the anodic coat is hard and resistant and it reaches a thickness not obtainable with the various aluminum alloys. However, it does not necessarily follow that satisfactory adhesion cannot be established on other than the purer forms of aluminum. All forms of aluminum may now be plated with a form of adhesion that is not in the least disturbed by sudden applications of heat sufficient for soldering, grinding and so forth.

The present commercial applications of the process are naturally limited to the defense industry and no aluminum is at the present time being plated for purely decorative purposes. Only what might be called "functional plating" is being practised. Aluminum is being plated with copper for soldering purposes, with brass for purposes of rubber adhesion, with cadmium for corrosion protection and with nickel and chromium for wear resistance.

When it was first proposed that aluminum be plated with copper or brass, many metallurgical engineers were loathe to believe that the combination of these metals was practical from the standpoint of the results that might ordinarily be expected on the basis of the electrochemical series. Aluminum and copper are far removed in the series and potential differences would ordinarily be high. This would be quite true if ordinary methods of plating were used but in the Krome-Alume process there remains between the copper and the aluminum basis metal the remnants of an anodic film and salt spray tests indicate that this new factor greatly interferes with what might ordinarily be the rule. Aluminum plated with 0.001 in. of copper has been able to withstand nearly 500 hours of salt spray testing before any form of serious corrosion set in.

Operations Involved

At this point it will be interesting to trace the operations involved in the actual practice of the process. The cleaning of the aluminum does not have to be either severe or excessive. As a matter

A plating installation at the plant of the Eastman Kodak Co., Rochester, N. Y.

of fact only the mildest cleaners are advised inasmuch as no etching of the basis metal is needed for the purpose of adhesion. An ordinary solution of sodium cyanide is quite sufficient for this purpose and cleaning can be accelerated to some extent by an application of direct current. The cleaning cycle is not much longer than that required for any other metal.

After the cleaning has been completed and rinsing has taken place, the aluminum to be plated is placed in an oxalic acid solution and anodizing proceeds for 10 min. by the use of alternating current. The alternating current source is variable in voltage between 5 and 50 in 5-volt steps. To prevent undue flow of current at the initiation of the anodic treatment, only 5 volts is applied. After a few seconds, anodic formation has proceeded to such a point and has imposed such resistance that a rapid increase in voltage to 50 is possible. This occurs during the first minute of treatment and after the voltage has reached 50 anodizing continues for 9 minutes more.

For some reason not thoroughly understood, anodizing and alternating current with oxalic acid seems to produce a form of anodic coating that is particularly adapted to plating. In operating the anodic bath, the current is allowed to flow between two work rods each bearing the same number of aluminum articles to be plated. As each piece is the same size and shape, it follows that current density distribution will be even and uniform. This produces a uniform anodic coat on all articles treated.

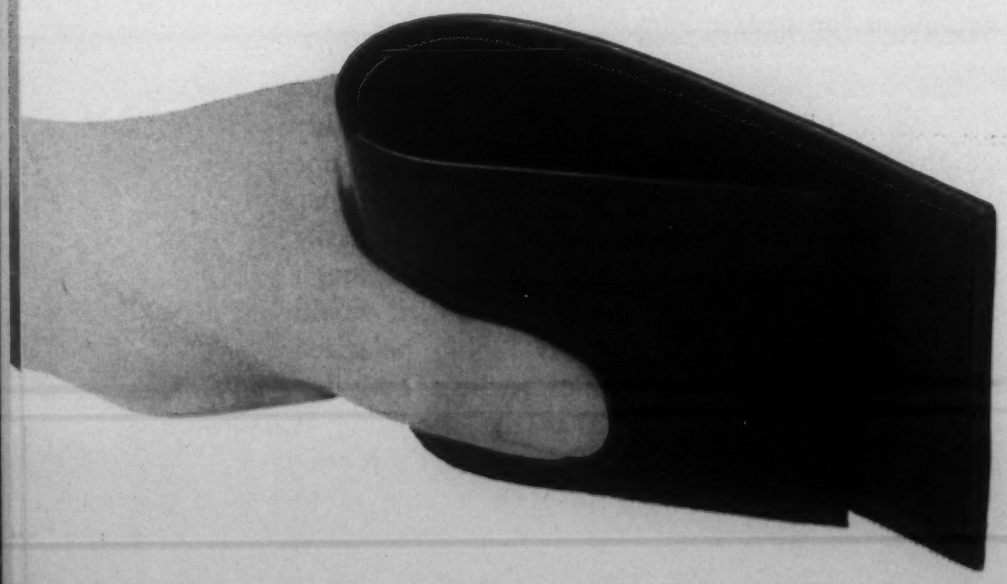
Inasmuch as the oxalic acid anodizing solution should not operate over a temperature of 85 deg. F., some method of cooling must be installed where tanks are worked hard during the summer time. Cooling can often be achieved by merely installing a cooling coil in the rinse tank. In larger installations where a great amount of work is to be done, a refrigerating process is indicated.

Modifying the Anodic Film

The crux of the process lies in a modification of the anodic film before plating. Should a freshly anodized piece of aluminum be placed in any one of the nickel baths, very low cathode efficiency would result and a gritty deposit that could be easily removed with the fingers would be made. Although the fact has not been definitely established, it would seem that this anodic surface is highly polarized by the occlusion of hydrogen or perhaps both hydrogen and oxygen inasmuch as the anodizing is done with alternating current. Subsequently this anodic surface must be plated in such a way as to eliminate the polarization. This is done by exposing

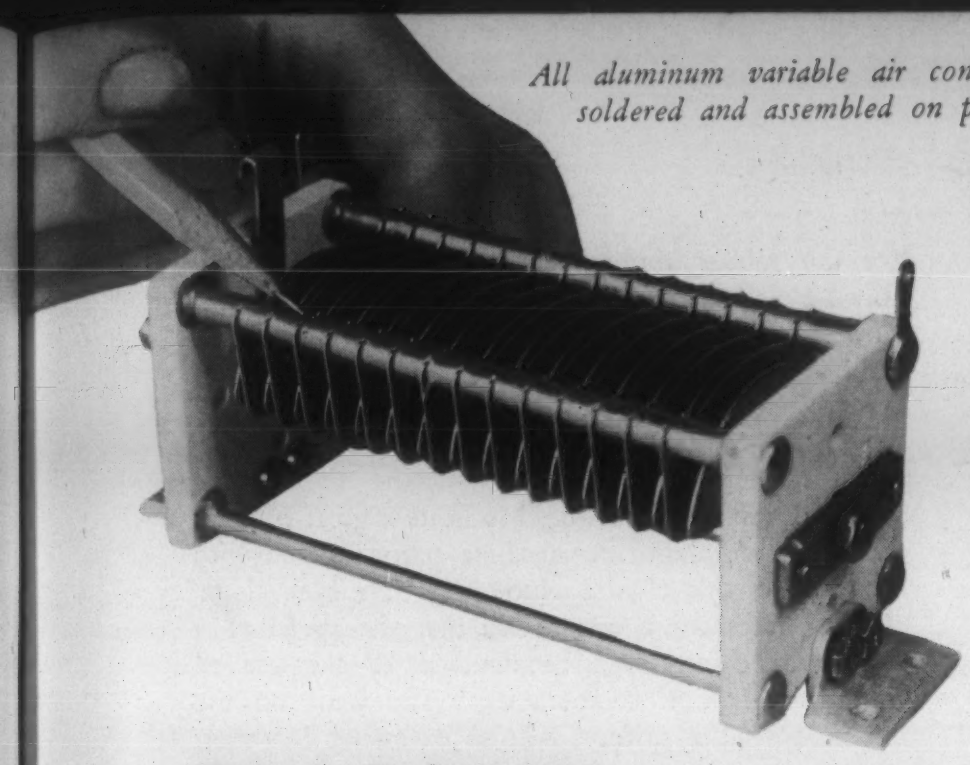
The anodizing transformer at the Eastman plating installation.

Electrically deposited (cathodic) rubber on brass-plated aluminum sheet.



the anodized metal to either one of a number of solutions that may be alkaline or acid. Best results are had by modifying this anodic film in a weak solution of hydrofluoric acid.

In the case of the purer forms of aluminum like the 2S or 3S alloys, there may be considerable latitude either plus or minus in the modification of the surface. The time will depend in any case entirely upon the strength of the hydrofluoric acid solution. The 2S alloys may be modified in anywhere from 3 to 15 mins. On the other hand, even very weak solutions of the hydrofluoric acid, will modify the anodic coat on duraluminum surfaces very quickly. In some instances no more than 30 seconds are required so to alter the coating that plating may be had. It is quite natural that the temperature of the hydrofluoric acid would have some effect upon the speed of the modification. However this factor is so small that unless the hydrofluoric acid solution is at an excessive temperature, practical operation does not call for strict control.



All aluminum variable air condensers for radio, soldered and assembled on plated surfaces.

Plating the Duralumin Alloys

In the case of all the duraluminum type alloys, modification is rather critical and it comes easily within commercial practice. If the metal is left in too long, the larger part of the anodic coat will be entirely removed and bad adhesion will result. If the exposure is not sufficiently long, poor adhesion will also result. It is to be pointed out that the anodic coat formation on the duraluminum type alloys are not nearly as thick as they are on the purer forms of aluminum. Consequently modification proceeds at a more rapid rate.

After modification has been completed, the articles to be plated are rinsed and they may thereafter be plated in most of the commercial plating solutions now in use. The only exceptions to this rule are in connection with the high temperature, high pH alkaline solutions. If direct plating is attempted with such solutions, modification of the anodic coat proceeds beyond a critical point before a deposit of metal can be achieved. Therefore when plating is attempted in these solutions it is usually necessary to plate a flash deposit on the metal before it is placed in the high alkaline bath. For instance, before articles are placed in high temperature copper plating baths, it is necessary to expose the metal to 10 min. of plating in an acid copper bath.

In all other cases involving the majority of the plating solutions now in use, the aluminum articles may be placed directly in these baths immediately after modification and rinsing. Direct deposits of cadmium, silver and brass may be had in this way. Plating proceeds at the same rate of deposit as for the more common metals. Excellent nickel deposits may be had from any of the commercial nickel baths whether water hot or cold, white or gray. In the case of all deposited metals, the adhesion is either as good as or in many instances better than that obtained over other metals.

Adhesion

It has been found that with most aluminum alloys or the purer forms of aluminum, the adhesion obtainable is better than that had on zinc or its alloys when even the most approved form of technique is used. In the case of the 2S and 3S alloys, adhesion reaches a point where it is practically impossible to remove the deposit except by rather violent chemical means. Such deposits may be heated in Bunsen flames, bent, ground or flexed to the breaking point without risking the danger of lifting the plating. In every instance, heat increases the adhesion rather than decreases it.

In one test aluminum sole plates for flat irons have been plated, heated to 700 deg. and quenched in buckets of cold water without affecting the adhesion of the deposit. The alloy used was No. 195 of the Alcoa series. In this case as well as in all others, heating increased the adhesion. The test was conducted with a deposit of 0.001 in. nickel and 0.0015 in. chromium.

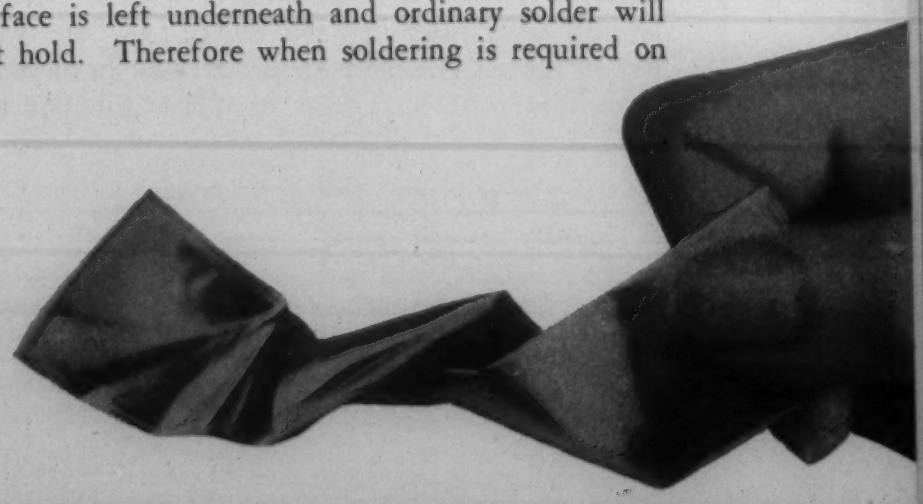
In the plating of 2S and 3S sheet material, a form of adhesion is achieved that makes it possible to punch and form these metals after plating. Prior to the opening of hostilities, a number of manufacturers were punching and forming many articles from pre-plated sheet material. Embossing was also practised with pre-plated sheets. Before the war this material was available in large sheets and also in strips.

Functional Applications

The war industries have discovered many functional applications of plated aluminum. The radio industry in particular has discovered a number of uses for plated aluminum and aluminum alloys. One of these has to do with greatly increasing the electrical conductance properties of aluminum through the application of silver. Where very high frequencies are employed, conduction losses have been reduced as much as 18 per cent. This is quite easy to understand when it is known that these ultra-frequency currents exhibit what is known as the "skin effect." They travel only on the surface of conductors. Prior to the introduction of the Krome-Alume process for this purpose, radio engineers were loath to use uncoated aluminum in radio operating in the UHF range.

The radio industry has also long sought deposits on aluminum that would be sufficiently great so that soldering by ordinary means at ordinary speeds would become possible. However where silver is applied directly to aluminum, soldering is not possible although the silver deposits will withstand an application of heat far in excess of that required for soldering.

The reason is very simple to understand. Apparently the silver on the surface of the aluminum passes into solution with the tin in the solder; the silver is literally dissolved from the surface of the aluminum. When this happens the bare aluminum surface is left underneath and ordinary solder will not hold. Therefore when soldering is required on



Nickel and chromium plated on aluminum sheet. The material is bent and flexed to show adhesion.

silver-plated aluminum, a flash deposit of nickel is placed on the aluminum first. Then, when the silver passes into combination with the tin, a nickel surface is left which takes the solder very nicely. Zinc directly on aluminum can be used if the proper precautions are taken. The temperatures used must be comparatively low with a large volume of heat available. Otherwise the zinc deposit will be melted.

Any one of the aluminum alloys may be made quickly available for ordinary soldering technique with a flash deposit of copper. About 12 to 15 min. in a copper bath is sufficient for this purpose.

Cadmium on Aluminum

Cadmium deposits made directly to aluminum are claimed by some authorities to be equally effective as anodic coatings. Such deposits are now being made commercially and apparently there is excellent promise for cadmium-plated aluminum in the future.

Recent experiments have shown that comparatively small deposits of nickel and chromium placed on the top of aluminum pistons used both in gasoline and Diesel engines may very effectively reduce burning in this area. It is obvious that at these elevated temperatures the alloying action between the deposit of nickel and the basis metal must be rather advanced.

Brass deposits made directly to aluminum surfaces were held in suspect by many metallurgical engineers for the same reason that copper deposits were held in suspect. Ordinarily one would think that because of the wide separation between brass and aluminum and copper and aluminum in the electrochemical series quick trouble from corrosion would result. In the case of aluminum, however, there is an X factor in what remains of the anodic coat, which takes its place between the basis metal and the deposited metal. The intervention of this coating has turned out to be a constructive factor inasmuch as many salt spray tests have confirmed the fact that corrosion does not proceed at a rate that might be expected. A deposit of copper of 0.001 in. in thickness has shown salt spray resistance up to nearly 500 hrs. While brass deposits do not run this high, they are sufficiently high to be much better than brass deposits on such metals as zinc.

Excellent oxidized decorative effects may be had on brass-plated aluminum and brass-plated aluminum has also been found to be very useful where it is required that rubber be adhered to aluminum surfaces. It has long been known that brass-plated steel offers an excellent surface for rubber adhesion. Apparently there is some form of involved chemistry that takes place between rubber and brass when left in contact. Aluminum plated with brass makes it possible to obtain a form of rubber adhesion that is in many instances limited to the tensile strength of the rubber applied. To date a great deal of brass-plated aluminum has been used by the rubber industry in connection with the production of certain aircraft parts.

Plated Duralumin Machine Parts

Work done to date would indicate a great promise for small duraluminum machine parts covered with deposits of nickel and chromium or nickel alone. In one instance, it was found that the speed of a certain machine could be doubled by the use of certain aluminum components. The wear on the aluminum alloy surfaces was so excessive, however, that the metal could not be used in an unprotected form. In such instances aluminum covered with deposits of nickel and chromium offer excellent promise.

Deposits of hard or soft nickel may also be used. The poor lubricating qualities of chromium have been largely overcome by porous deposits whereas nickel itself offers no lubricating problems. Work already done by some of the large automobile companies also indicates that there is great promise for aluminum pistons plated with nickel and chromium. These deposits do not have to be heavy to achieve the results required.

A careful analysis of the possibilities of plated aluminum cannot help but lead to a recognition of the fact that plating will point the way to many new applications that have been heretofore denied this metal. Previous processes for plating the metal have been both expensive and uncertain except perhaps in the case of chromium direct which, from a metallurgical viewpoint, is not all that is to be expected. Heretofore nickel deposits have not been sufficiently adherent to warrant extensive application and deposits from alkaline solutions have been difficult and uncertain.

The Problem of Cost

Extensive use of the process shows that the cost of plating aluminum is not much higher than that for plating other metals. If the copper cycle is included in zinc platings, the plating of aluminum is as cheap if not cheaper. The pre-plating process or treatment for aluminum averages about a quarter of a cent per square foot. The time required for the pre-plating treatment varies with the alloy to be plated. In the case of the 2S and 3S alloys about 15 min. is required whereas the duraluminum series requires about 12 min. Standard tank equipment is used and all equipment is standard except the special transformer required for the anodizing. It is to be noted however that alternating current equipment for anodizing is much cheaper than direct current supply.

Reference Table of

ALTERNATES AND SUBSTITUTES

Compiled by Fred P. Peters

The tabular data on this and the following page are intended to serve as a guide to possible alternates for "scarce" materials or "tight" fabricating methods in the design of ordnance equipment and parts. That the Ordnance Department itself has introduced many of the substitutions listed (not to mention similar specification changes permitting the use of alternates in more than 400 ordnance items not made public) is a notable sign that the days of prodigal military design are passing.

The particular arrangement of this table is intended to bring out the fact that many of the substitutions involve the replacement of a wasteful or time-consuming fabricating process by a process that is more efficient, rather than the substitution of one material by another. The columns headed "Form" are significant in this respect.

For previous sections of this continuing tabulation, see M & A for Jan. 1942, p. 80 (Household Products); Mar., p. 403 (Motor Vehicles); Mar., p. 404 (Engineering and Machinery Steels); July, p. 68 (Brasses and Bronzes); and Sept., p. 437 (Electrical Equipment and Parts).

SECTION 5—ORDNANCE EQUIPMENT AND PARTS

Part	Former Design		Alternate Design		Remarks
	Material	Form	Material	Form	
Ammunition boxes	tin plate	sheet	fiber coated with lead	laminate	saves tin, copper
Ammunition boxes	tin plate	sheet	enameled steel	sheet	saves tin
Anti-aircraft gun bearings	bronze	castings	Cu-Mo iron	castings	saves copper and tin
Armor-piercing shot	steel	machined bar	steel	bar-forgings	saves 30% of material, improves quality
Armor-piercing shot windshield	aluminum	die castings	steel	deep-drawing	saves aluminum
Armor plate	high alloy steel	rolled plate	low-alloy steel	rolled plate or castings	nickel, chromium and vanadium saved
Artillery gun barrels (1-5 in.)	steel	forgings	steel	centrifugal castings	saves time, machine work and steel
Artillery shell fuses	aluminum	machined bar	secondary aluminum	die castings	saves primary aluminum and machine-scrap
Bayonet grips	steel	machine forgings	plastic	molded, thermo-setting	saves steel, machine-time
Bearings	bronze	castings	indium-plate	electro-plate	saves copper, tin
Bearings	bronze	castings or powder metallurgy	iron	powder metallurgy compacts	saves copper, tin
Bearings	tin babbitt	castings	lead babbitt	castings	saves tin
Bomb adapters	steel	machined bar	steel	brazed stampings	saves steel, screw-machines; uses copper for brazing
Bomb burster casings	brass	machined bar	steel	resistance welded assembly of stamping, tubing and machined parts	saves metal, machine-time
Bomb fuses	aluminum	various	plastic	molded thermo-setting	saves aluminum
Bomb lugs	steel	machined forgings	steel	stampings	saves steel, machine-time
Bomb rack clips	aluminum	stampings or die castings	steel	stampings	saves aluminum
Bomb tail fins	aluminum	die castings	steel	resistance-welded stampings	saves aluminum
Boosters	brass	machined bar	steel	machined-bar	saves copper, zinc
Bullet jackets	gilding metal (brass)	cold pressings	steel, clad with gilding metal	cold pressings	saves copper, zinc
Cartridge cases	brass	drawn	steel	drawn	saves large amount of brass
Cartridge tank	aluminum	machined bar	steel	stampings	saves aluminum, machine-time
Dash pot piston	steel	machined bar	steel	brazed plate and machined-bar assemblies	saves steel, machine-time
Demolition bomb casings	steel	forgings	steel	welded sheet	saves time and material, and releases forging presses

ALTERNATES AND SUBSTITUTES IN ORDNANCE EQUIPMENT

Part	Former Design		Alternate Design		Remarks
	Material	Form	Material	Form	
Driving rings	copper	cut tubing	gilding metal	tubing	saves copper
Fin lock nuts	steel	machined forgings	steel	stampings	saves steel, machine-time, money
Fuse setters	bronze	castings	gray iron	castings	saves copper, tin
Gears	high alloy steel	forgings and machined bar	NE steels	forgings and machined bar	saves nickel, chromium
Gun mount components	aluminum	plates	steel	ribbed stampings	saves aluminum
Gun mounts	steel	castings	steel	weldments	saves time, machining, steel, weight
Gun spring casing	steel	machined forgings	steel	forging and drawn sleeve welded	saves steel (42 lbs. of scrap per forging), time, money
Hand wheels	aluminum	machined bar	steel	riveted stampings	saves aluminum, machine-time
Instrument housings	aluminum	stampings	plastic	molded, thermo-setting	saves aluminum
Locking rings	steel	forgings	steel	brazed stampings	saves steel, machine-time
Machine gun handles	steel	machined bar	plastic	molded, thermo-setting	saves steel, machine-time
Machine gun magazine	steel	machined forgings	steel	spot-welded stampings	saves steel, machine-time
Machine parts	high alloy steel	forgings and machined parts	NE steels	forgings and machined parts	saves nickel, chromium
Name plates	bronze	stampings	lead	stampings	saves copper, tin
Pins	high alloy steel	machined bar	NE steels	machined bar	saves nickel, chromium
Pistol grips	steel	machined bar	plastic	molded, thermo-setting	saves steel, machine-time
Primer cases	brass	machined bar	steel	stampings-assembly	saves brass, machine-time
Primer tubes	brass	tubing	steel	stampings	saves brass
Rotating bands	copper	cut tubing	mild steel	tubing	saves copper
Shafts	high alloy steel	machined bar	NE steels	machined bar	saves nickel, chromium
Shell fuse plugs	aluminum	die castings	zinc	die castings	saves aluminum
Shot	high alloy steel	forgings or machined bar	lower-alloy or carbon steels	surface-hardened	saves strategic alloys and heat-treating time
Small parts	steel	machined bar	iron	powder metallurgy compacts	saves machine-time
Smokeless powder container liners	tinned copper	sheet	18-Cr-stainless steel	sheet	saves tin, copper, considerable weight
Spur gears	iron	machined castings	iron	powder metallurgy compacts	saves material, machine-time
Suspension guide fitting	steel	3 machined forgings	steel	brazed stampings	saves machine-time, cost
Switch housings	steel	stampings	plastic	molded, thermo-setting	saves steel, machine-time
Tank armor	steel	fusion-welded sheet	steel	flash-welded	saves stainless steel weld-rod, man--hours
Trench mortar shell fuse bodies	aluminum	machined bar	plastic	molded, thermo-setting	saves aluminum
Trench mortar shell fuse booster cups	aluminum	die castings	plastic	molded, thermo-setting	saves aluminum
Trench mortar shell fuse heads	aluminum	machined bar	plastic	molded, thermo-setting	saves aluminum
Trench mortar shells (60-mm.)	steel	forgings	malleable iron	castings	saves steel, machine-time; speeds production
Trigger cover plate	steel	machined forgings	steel	welded stampings	saves machine-time, steel
Valve wheels	bronze	castings	steel	weldment	saves bronze, increases production, saves money

(Editorial continued from page 1061)
which we can never be thankful enough. And to know that they have been and will continue to be largely employed in solving the Nation's urgent metallurgical problems in these historic days should be a source of immense gratification to every American engineer.

"Gillettisms"

Gillett's actual writings, and particularly the "homespungencies" that characterize and illuminate his editorials, have been both a moving force and a delight to readers everywhere. Sometime we should like to see a collection of "Gillettisms" published — we think the best of them present the basic tenets of good engineering practice in a way that no *human* being can possibly resist.

For example, he has persistently denounced certain practices and conditions that were inimical to technological progress. These he called his "Pet Peeves," and he took the trouble to enumerate them in our October 1936 issue (page A 15). Thousands of readers have personally and often shared his annoyance with New Deal political maneuvering, with professors who maintain no contact with industry, with writers who convert a rounded centigrade temperature to its exact Fahrenheit equivalent, with people who use "general averages" of physical properties when they should be using values for specific analyses or heat treatments, and with anyone who argues from the specific to the general.

He has been a prime mover in rationalizing metallurgical engineering *nomenclature*. "Crystallization" instead of "fatigue damage," "inherent grain size" when "grain-coarsening propensity" is meant, "chrome steel" for the more accurate "chromium steel," and many others, have been anathema to him.

But Gillett's influence has been most widely felt in the things he was *for,* rather than against. To our working vocabulary, for example, he has added "nickel brass" and "mild alloy steel," not to mention the expressive "load - carrying - ability - without - too - damn - much - deformation" for 0.2 per cent offset yield strength, and the concise "diaper yield strength" for 0.02 per cent offset yield strength (June 1940, page A 37).

On the importance of *direct tests,* Gillett has been most articulate. This sample from the September 1939 issue (page 259) is typical:

> Unfortunately, most such determinations involve considerable work and hence are handicapped in competition with the lazy man's way — evaluating the material on the basis of percentage elongation and trusting to God that the figure means something in the particular service to be encountered.

Similarly, in the June and October 1942 issues he took up the cudgels in favor of more sensible application of the low-temperature notched-bar impact test, now keeping lots of otherwise good steels out of service where low-temperature toughness is not at all necessary.

Some of his advice on *business and engineering* is worth recalling. A vigorous exponent of the concentrated commercial development by each company of its own "supremacy area," he has also repeatedly reminded manufacturers of the importance of continual research as the price of survival. And on promotion (November 1939) he says:

> The permanent utilization of a material is better advanced when the producers have the interests of their customers at heart than when they exert sales pressure by which the unknowing user is persuaded to use more than he needs. . . . When the producer takes the attitude that his product must win its place purely on the basis of its engineering merits, and goes out of his way to prevent wasteful use, a feeling of good will and confidence is built up that is as real an asset as any other in the balance sheet.

How peculiarly true that is today!

On the *political aspects* of metals and war he has been much more far-sighted than most of us. Typical of his frequent comment before

(Editorials continued on page 1092)

(Editorials continued from page 1091)

the war about the need for building *stockpiles* of strategic materials is one in September 1941, in which he refers to " 'mutual disarmament' — where the United States scrapped ships and the others scrapped blueprints" and suggests that "all the necessary metals should be stockpiled in at least a 3-years' supply at a rate of consumption considerably greater than our maximum annual need for them in the present emergency."

Gillett has never been reticent about politicians who obstruct progress or the general welfare for politically selfish reasons. Noting that the New Dealers may be forced into an unwilling truce with producers during the emergency, he warns (January 1941, page 41):

> Leopards do not change their spots and polecats require a surgical operation to become odorless. So when the emergency is over, any truce will end.

In the June 1941 issue he established the hypothetical "Order of Judas Iscariot" to comprise those labor leaders, employers and government officials who intentionally or unintentionally delay the defense program. As for the unintentionals ("those who are just too dumb to see that insistence on their pet panaceas for social ills has the same effect as if it were intentional"), Gillett says "We respect the 5th columnist quite as much as the 4½ columnist."

"Political metallurgy," he avers in his article on conservation in the October 1942 issue, "is weird and wonderful," and he brands the "jackass politicians" of the silver bloc as "domestic JAPs" who need licking quite as much as the foreign ones.

We could go on like this interminably, setting down, for example, dozens of Gillettigrams like:

> (speaking of specialists) "If all gentlemen preferred blondes, the biological results would be unsatisfactory"; or
>
> "It wouldn't be a bad idea to include a course in skepticism in the sophomore year of a metallurgical curriculum"; or again
>
> "Eradicating a false impression is difficult enough, but eradicating it once it gets into specifications is like cleaning the Augean stables."

But this has been enough to demonstrate the power of Gillett's pen.

A Truly Great Metallurgical Engineer

One of the best (although unwitting) descriptions of Gillett's own nature is contained in an editorial he wrote for our April 1941 issue (page 448), in which he paid his tribute to such broad-gage men as Howe, Campbell, Sauveur Moldenke, Mathews, Bassett, Spring, Bull, McKinney and John Johnston. We quote:

> Not the least of the virtues of this galaxy was the personality of each, their farsightedness, their lack of self-seeking, their forthrightness in thought and expression and their interest in the advancement of metallurgy. . . . They never used their committee connections for the monetary advantages of their firms or clients. . . . It is not hard to recognize the people who do look at things broadly. When a youngster has an opportunity to confer with, or do committee work with individuals of that type he should seize it. . . .

Gillett is precisely such an individual. And all of us at METALS AND ALLOYS — youngsters as well as oldsters — are proud and happy for this opportunity to have worked with one of metallurgical engineering's greatest figures.

No, Dr. Gillett — *we* thank *you!*

—The Editors

Safety for a nation at war . . . The Army on wheels, like the army in overalls, depends on "A.W." Rolled Steel Floor Plate to prevent costly disabilities. Here is the right combination of underfoot protection and longest possible wear. "A.W." Floor Plate is fire-proof, heat-proof, oil-proof, crack-proof. Cleans easily, drains easily. Installed with minimum of time and labor.

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Courtesy U. S. Army
Signal Corps

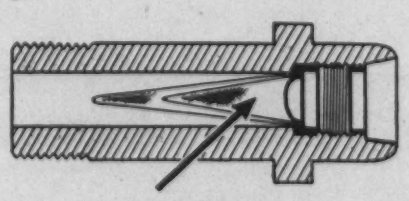
How to Make Welding and Cutting Regulators Last Longer . . .

GOOD oxy-acetylene welding and cutting depend to a great extent upon smooth, unfluctuating delivery of gases to the blowpipe. This, in turn, depends upon the action of the regulators that reduce the cylinder gas pressure to the desired working pressures. Because of the very nature of the work they perform, oxygen and acetylene regulators must be precision-made. Moving parts must work smoothly and seating surfaces must close tightly. So—while sturdily made—Oxweld, Prest-O-Weld, and Purox regulators should be recognized as *sensitive instruments* and should be treated as such. The suggestions outlined here will help you to make your regulators last longer and work more efficiently.

KEEP DIRT OUT OF REGULATORS

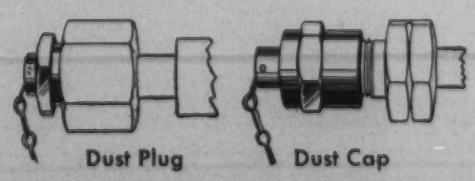
1. ***Crack the cylinder valve*** slightly for an instant and then close it, before connecting a regulator to the cylinder. *This will blow dust and dirt out of the valve and will not only reduce the likelihood of forcing dirt into the regulator, but also will help to avoid damage to the seating surfaces on the regulator inlet connection.*

2. ***Dust screens*** are built into the inlet passages of most Oxweld, Prest-O-Weld,


Dust Screen

and Purox oxygen regulators. Do not remove these screens except for periodic cleaning, after which they always should be replaced immediately. *Be careful not to tighten the locking ring too tight as this may shear off the brass screening. Pull it up until it is just "snug".*

3. ***Dust caps*** or plugs are provided on


Dust Plug Dust Cap

most Oxweld regulators. If your regulators are so equipped, screw them into place whenever the regulator is not attached to a cylinder. Do not remove the chains that attach dust plugs and dust caps to the regulators, as the chains prevent them from being lost.

AVOID EXCESSIVE STRAINS

4. ***When turning gas on*** after attaching a regulator, open the cylinder valve only slightly at first to avoid a sudden rush of high-pressure gas into the regulators and regulator gauges.

5. ***Always release gas pressure*** from regulators when the equipment is not being used. First close the cylinder valves. Second, open the blowpipe valves to release all pressure. Then close the blowpipe valves. *If this is not done, even a very slight leak in the regulator valve seat may permit excessive pressures to build up in the delivery chamber of the regulator and in the hose. This might result in straining the low-pressure gauge or regulator valve, or may even rupture the safety-release disk or the hose.*

6. ***Always release the pressure-adjusting screw*** after relieving the pressure as described in par. 5. To do this, turn the

handle to the left until it turns freely. *This will greatly prolong the life of the diaphragm.*

MAINTENANCE SUGGESTIONS

7. ***Test for leaky valve seats*** at regular intervals. To do this, attach the regulator to a cylinder, release the pressure-adjusting screw, open the cylinder valve, and apply a film of soapy water over the regulator outlet connection. *If the regulator valve seat leaks, the gas that leaks through will blow a bubble and burst the soapy film. Do this periodically, and replace at once seats that leak. This will avoid possible extensive damage and repairs.*

8. ***If a safety-release disk breaks,*** replace it only with the correct part as specified in the instruction book supplied with the regulator. Do not use substitutes. *This is important because disks not specially made to rupture at a pressure commensurate with pre-determined safety requirements may permit pressures to build up, without being released, to a point that could do serious damage.*

9. ***Replace broken gauge crystals at once.*** If this is not done, the needle indicator may be damaged or the dial face may become so dirty that it will not be possible to adjust the regulator accurately to the pressure required for good work.

DUPLICATE INSTRUCTION BOOKS AVAILABLE

It is important that oxy-acetylene apparatus be operated and maintained in accordance with the manufacturers printed instructions. Duplicate copies of the instruction booklets packed with all oxy-acetylene apparatus supplied by Linde can be obtained from any Linde office.

The words "Linde," "Oxweld," "Purox," and "Prest-O-Weld" are trade-marks.

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METALLURGICAL ENGINEERING shop notes

Angle of Chip Breaker in Reverse

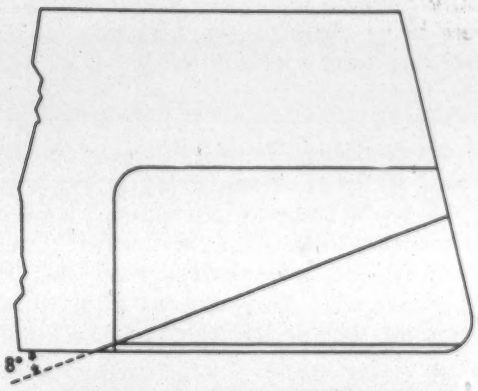
by Malcolm F. Judkins
Firth-Sterling Steel Company

An unusual solution to a difficult problem of machining stainless steel has been discovered by the Firth-Sterling Steel Company, McKeesport, Pa. The material used is soft but extremely tough, and it is necessary to cut through scale in a rough turning operation.

Although many types of grind were tried, including negative top and side rakes, positive rakes with negative lands, parallel and angular type chip breakers and dulling the cutting edge at the scale line, the tools invariably chipped at the scale line or were worn away at that point after a run of only 5 minutes.

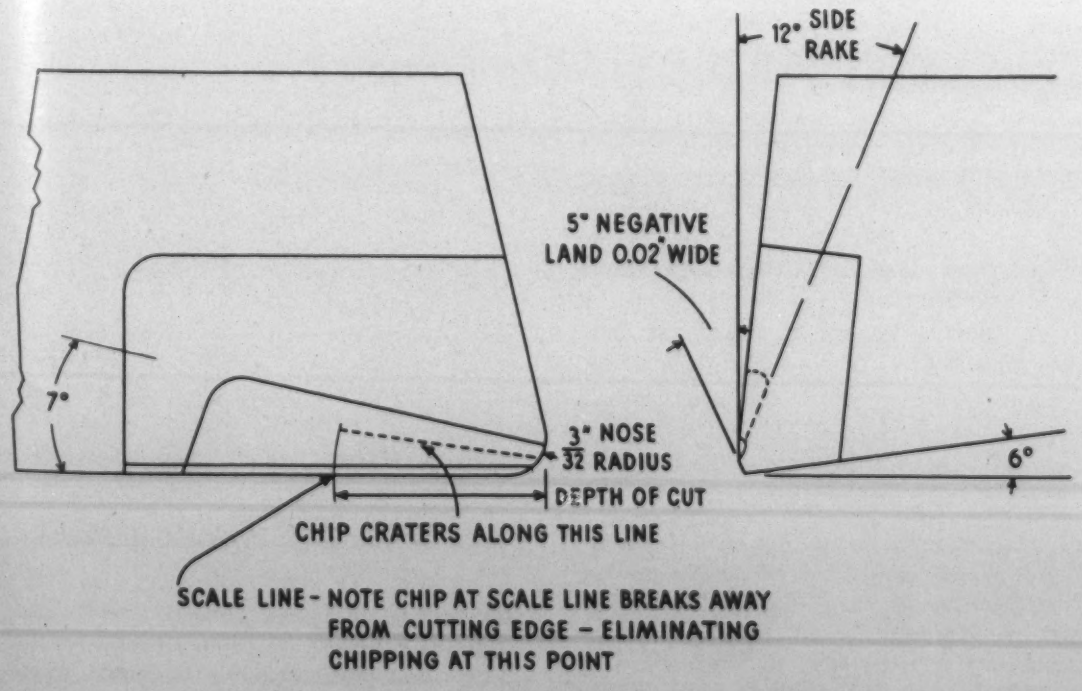
The solution was found in reversing the angle of the chip breaker. The usual practice in the grinding of carbide tools for cutting of steel is to grind the chip breaker wide at the nose of the tool and to taper the groove off in the direction of the shank. This procedure was reversed. As indicated by the drawing, the chip breaker was ground to an angle of 7 deg., with the narrow end of the groove starting at the nose radius. This was done with the thought that the chip cleavage would occur further ahead of the cutting edge at the scale line than at the nose radius.

This grind of the tool prevented edge failure even at double the feed and speed formerly used. A tool life of 8 hours was secured at a speed of 200 ft. per min.



CONVENTIONAL DESIGN OF CHIP BREAKER

and a feed per revolution of .012 in., using grade HA Firthite without cutting fluid.



CHIP BREAKER TO PREVENT WEAR AT SCALE LINE

Lead for Tin in Engine Bearings

by W. T. Burgess,
Cooper-Bessemer Corp.

Because of the plentifulness of lead and scarcity of tin, alloys of lead as base metals have been put into bearings of Cooper-Bessemer diesel engines and air compressors. They are apparently doing very well, though a year of testing will be required. Certainly its use in an internal combustion engine such as a heavy duty diesel, where it must stand up under high temperatures and pressures, is a most critical test.

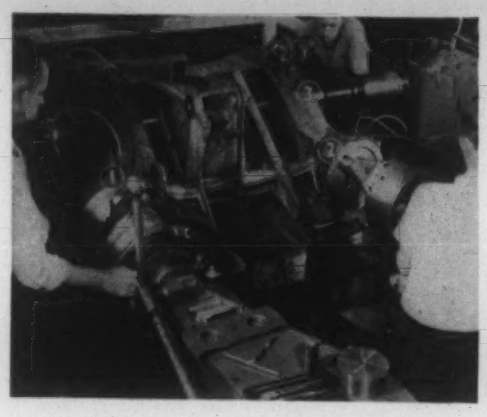
In fact, there are indications that the lead bearings will be better than the company has ever produced before. Heretofore, automobile bearings have contained between 88 and 90 per cent of tin, with 7½ lbs. of tin per car.

(More Shop Notes on page 1096)

Improving Machine Versatility

by W. S. McLean
Fisher Body Div., General Motors Corp.

When the Fisher Body Div. undertook production of powerful anti-aircraft weapons, the Ternstedt Mfg. Div., assigned to the gun job, found they had to build the boring machines themselves.



These are unique applications of single purpose equipment for multiple duties.

Standard type heads were designed so that parts for them could be farmed out to small machine shops unable to build entire machine tools. As the boring heads were being obtained, the remainder of the machines were specially designed for specific jobs.

One machine does the work of two or three ordinary boring mills, while one special set-up of seven machines does work of 46 to 52 ordinary machines. Two or three boring heads work on one part simultaneously, the fixture setting-time also being conserved. Also, they perform varied operations such as boring, facing and milling.

In the accompanying photograph, machines (1) and (2) are facing, while (3) is boring. One set-up does the work of seven ordinary machines. The difficult job of accurately setting the part into a fixture must be done only once instead of several times. The job here is an anti-aircraft gun upper carriage.

Welding Off-Size Castings

by Merritt L. Smith
Metal & Thermit Corp.

A machinist made an error in cutting a taper in a 750-lb. steel casting for a steam turbine, the finished taper being ½ in. too large. To repair the taper, the entire outside of the casting was wrapped in adhesive tape. A suction fan was installed to remove the fumes and smoke.

The operator thereupon started to build up the inside of the taper, using two rods welded together to reach the bottom. About 38 lbs. of 3/16 in. straight polarity electrodes were used, the job consuming 12 hrs. After re-machining the taper, no trace of the weld could be found.

Savings were estimated at $2500, states the Seaman Body Plant, Nash Kelvinator Corp., where it occurred.

Designers of industrial equipment involving insulation will be interested in a glass fibre board for the heat insulation and interior finish of fighting ships and auxiliary vessels which, since the first of the year, has saved 5,500,000 lbs. of aluminum, as well as other materials. The board is treated with a binder. On the service side, it is faced with incombustible glass fibre cloth, applied with flame-proof cement. Millions of entrapped air cells afford insulation.

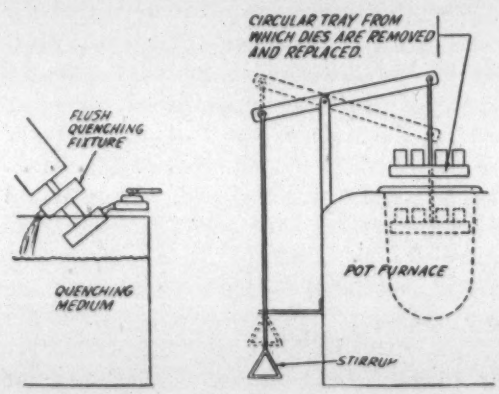
—Owen-Corning Fiberglas Corp.

Continuous Quenching With Stirrup Tray

by J. B. Froblom
Lindberg Steel Treating Company

A home-made contraption facilitates the flush quenching of parts one at a time, which has certain advantages over batch quenching. Here, parts are heated in a circular tray, which is immersed in the heating bath. Placing foot on the stirrup, the tray is raised from the bath, both hands being free to tong the die from the liquid heating bath to the quenching fixture.

A cold die is now put in the tray in place of the die just quenched, and the fixture re-lowered into the bath. Parts



are ready for quenching at 1 to 10 min. intervals. Thus, 10 header dies, 1½ by 3 in., could be placed on a 12 in. diam. circular tray (used in a 14-in. diam. furnace) and one die would be ready for quenching every 4 min. Such dies would take an hour to heat in a batch and 10 min. to quench, thus turning out 10 dies every 70 min., whereas the fixture uses 40 min.

Advantages are: Time saved by not waiting for entire batch to heat; fuel saved because pot furnace is burning steadily with throttled flame; in batch heating, a large flame is needed to regain the temperature, resulting in heat loss through the flue.

Invisible flaws in steel parts are detected magnetically by a machine built by P. H. Brace and C. S. Williams of the Westinghouse Research Laboratories. The part is magnetized and rotated at high speed. If it is perfect, its magnetic field is uniform; an imperfect piece creates a magnetic disturbance, which is shown on the screen of the oscilloscope.

—"Research Progress", Westinghouse Elec. & Mfg. Co.

Explosive Rivets for Airplane Repairs

D. L. Lewis, Jr.
E. I. duPont de Nemours & Co., Inc.

A clever idea adopted in one place is often used in an unrelated industry. Explosive rivets, used first in aircraft production, are now used in the field on damaged planes. Perhaps they will soon have other extemporaneous repair applications. Explosive rivets of aluminum alloy, introduced a year ago to aircraft production, can now perform repairs in hours instead of days.

High explosive is secreted in a cavity at the end of the shank. Heat applied to the rivet head by an electric gun detonates the charge. The explosion expands the charged end of the shank, forming a "blind" head and setting the rivet. The whole operation is performed from one side.

Saw Makes Clock-Spring Chips

by Otto Siles
E. C. Atkins & Company

A newly designed saw reduced the cutting time from 8 min. to 10 sec. on 2½ in. electric cast steel used in tank arm brackets. The innovation won for the author the War Production Drive award. The feature of this fast-working saw is the tooth design. Formed with an inward curved cutting edge, the tooth produces a curled chip resembling a clock spring. The cutting edge bites into the material at a slight angle, leaving the chip and keeping it rolling within the curved contour of the gullet.

As the tooth finishes the cut, the curled chip is released and no broken tooth runs through the cut a second time to jam in the gullet or to retard clean, crisp cutting action. Hence, heavier feeds and faster cutting speeds result.

Among the features are the large-size gullets that accommodate a large volume of material and a buttressed tooth construction, adding to tooth strength and allowing heavier feed rate. On the tank arm brackets the saw was run counter clockwise,

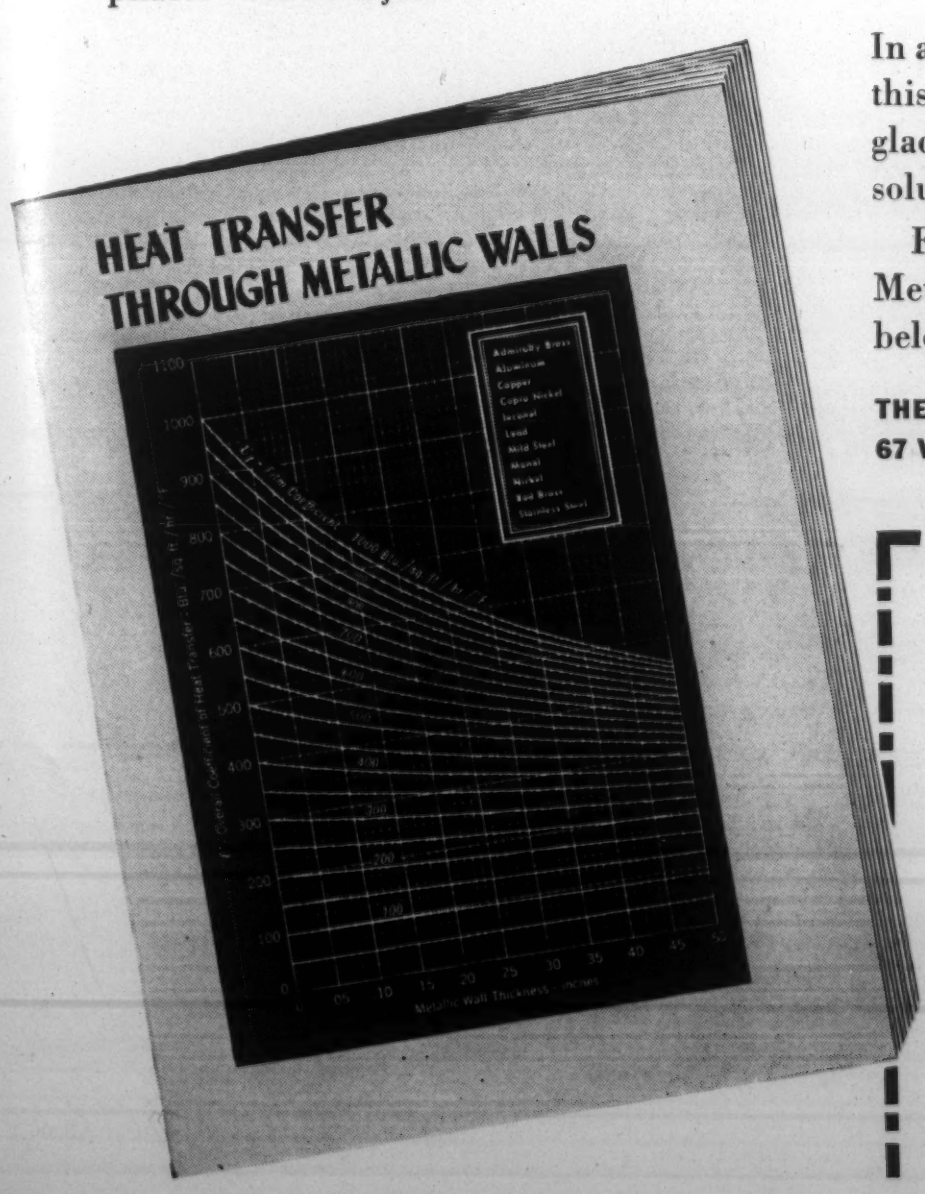
thus eliminating tooth breakage, which had been predominant, retaining the oil in the gullets and permitting the clearance necessary.

Cooperating with the author was J. A. St. Clair, saw designer of E. C. Atkins & Company.

How to calculate Rate of Heat Flow through Metallic Walls

As a result of work done by INCO Technical Service, a new booklet, "Heat Transfer through Metallic Walls," has recently been printed.

It explains in detail how to calculate heat transfer, and covers conductance values of film, scale, and condensing vapor film. It also includes tables on thermal conductivity of various metals, conductance ranges for metallic walls and films and other phases of the subject.



A valuable section of "Heat Transfer through Metallic Walls" consists of charts on heat transfer co-efficients for 11 different metals:

Copper	Lead
Aluminum (2S)	Cupro Nickel (70-30)
Red Brass (85-15)	Monel
Admiralty Brass	Inconel
Mild Steel (SAE 1020)	Stainless Steel (Type 430)
Nickel	Stainless Steel (Types 304, 316, 321)

In addition to the information contained in this bulletin, INCO Technical Service will gladly furnish personal assistance in the solution of specific heat transfer problems.

For copies of "Heat Transfer through Metallic Walls" please mail the coupon below.

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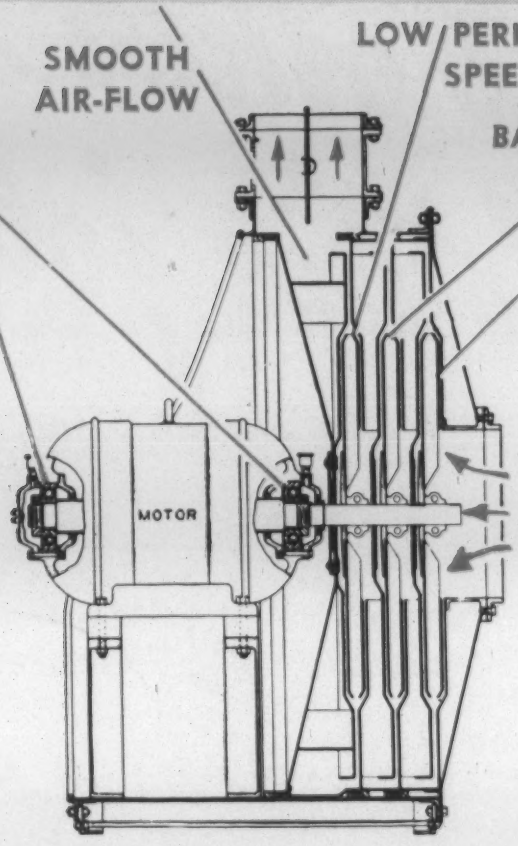

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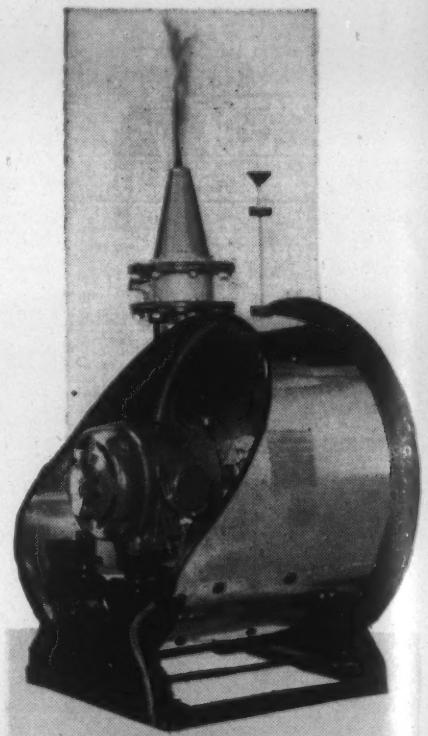

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Light Metal Aircraft Castings

Condensed from "The Foundry"

The greatest demand for the aircraft industry are aluminum and magnesium alloys. The least demand is for zinc castings. The type of casting process used depends on several factors. For large and intricate castings, a sand mold is necessary. A metal mold or steel die is used when large numbers of castings of the same pattern are made to justify the cost of the mold or die.

Dimensional tolerances of permanent mold castings are intermediate between those of sand castings and of die castings. Plaster mold castings are similar to sand castings but with smoother surfaces and closer tolerances. Permanent mold castings have the advantage over sand castings of greater ultimate strength, but lower ductility, more exact size and better surface.

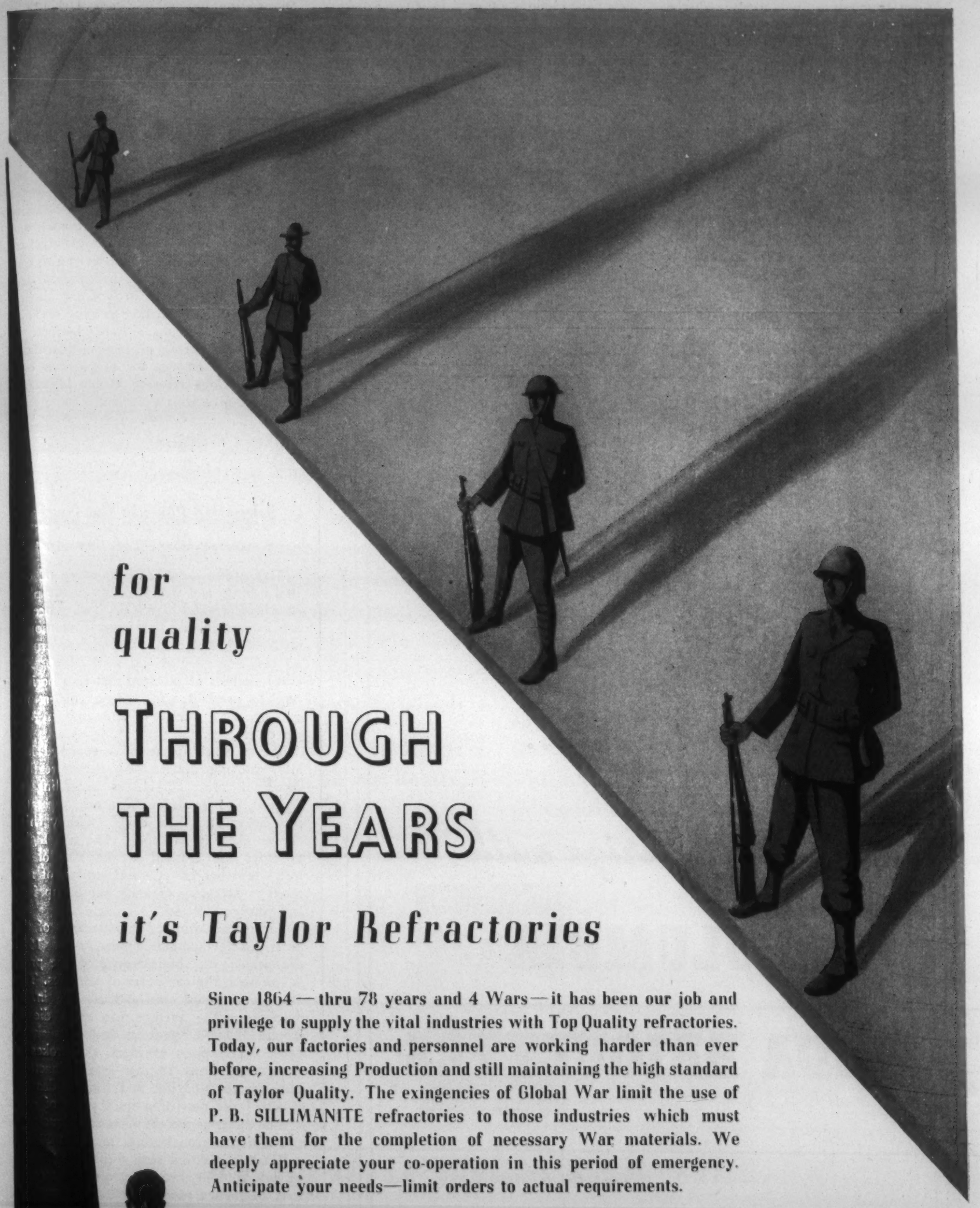
Die casting is used to produce castings in which extreme accuracy, uniformity, and superior finish are essential. Sand casting alloys may be cast in smaller castings with $\frac{1}{8}$ in. minimum wall thickness. The usual allowance for machining is 1/16 in. Permanent mold castings, can be cast with 3/32 in. minimum wall thickness. Sections in die castings can be produced as thin as 0.020 in. The section tolerance is ± 0.0025 in. Plaster mold castings can be held to tolerances of ± 0.005 in. or better.

Alloying Aluminum and Magnesium

By alloying additions to aluminum and magnesium, tensile strength and casting properties are improved. Silicon-aluminum alloys are very fluid and are used for thin walled and complicated castings. They are leak proof and have good corrosion resistance. High silicon-aluminum alloys are difficult to machine. Copper-aluminum alloys respond to heat treatment, and, therefore, have high strength and hardness. They are not used for thin sections. Copper-silicon-aluminum alloys are particularly suitable for permanent mold and sand castings. They have a wide application, since they respond to heat treatment, producing good mechanical properties. They are leak-proof and retain their strength up to 400 deg. F.

Magnesium-aluminum alloys are difficult to cast, but have maximum resistance to corrosion. They are not recommended for intricate or leak-proof castings. Magnesium-copper-aluminum alloys can be heat treated. Nickel-magnesium-aluminum alloys have good properties at high temperatures. They retain their strength up to 600 deg. F. and can be heat treated. Aluminum-magnesium alloys are usually sand cast for aircraft construction.

There is practically no limit to the size and core complexity of castings. Cast alloys have low strength at temperatures just after solidifying, and, if free contraction is not permitted, cracks may be produced. In sand castings, 3/16 in. per ft. unrestrained shrinkage is allowed and 5/32 in per ft. restrained shrinkage, by bosses or cores. In die casting maximum wall thickness is 0.375 in., while minimum is 0.060 in.



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When magnesium alloys replace aluminum, increases in wall sections are seldom needed. Replacing iron or steel, a redesign of important sections is necessary.

Aluminum-Silicon Alloys

An aluminum alloy with 5 per cent Si and 95 per cent Al for permanent mold casting has low tensile and low yield strength, and is used for complicated and thin walled castings. It can be cast in sand molds. Aluminum alloy with 12 per cent Si and 88 per cent Al has good casting qualities, high fluidity and freedom from hot shortness, and is used for die castings.

Magnesium alloy permanent mold castings are used for landing wheels, crankcases, etc.; die castings are used for engine rocker box cover, tube fittings, etc.; sand castings are used for engine crank cases, gear cases and covers, brake assemblies, manifolds, etc.

Certain aluminum castings, through addition of alloy elements, respond to heat treatment which imparts mechanical properties superior to alloys in the as-cast condition. Castings after heat treatment will, after 3 to 4 months, undergo aging reaction resulting in an increase in tensile and yield strength and hardness, with decrease in ductility. Complete aging can be accelerated by precipitation hardening. Certain magnesium alloys also respond to similar heat treatments. At solution treatment temperature, atmospheric control should be used to avoid scorching.

Anodizing Treatment

A chemical treatment such as anodizing should be given aluminum castings to improve the appearance and avoid corrosion. An anodic treatment of magnesium castings has been in use and is known as the PT13 treatment. Rough castings and wrought stock generally are given a chrome pickle treatment, consisting of a short-time dip in a solution of sodium dichromate and nitric acid. Finish machined castings are given an alkaline dichromate treatment, consisting of a dip in dilute hydrofluoric acid followed by boiling in sodium dichromate. For impregnating porous castings, solutions of sodium silicate, lacquer, or bakelite are used for aluminum, and chinawood oil or lacquer for magnesium castings. Castings showing visible blowholes are never given this treatment.

—*Foundry*, Vol. 70, Aug. 1942, pages 70-71, 146-153

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Briquetted Chips in The Cupola

Condensed from "The Iron Age"

This article describes briquetting of cast iron borings and steel turnings at the plant of Allis-Chalmers Mfg. Co. Two processes are in operation. One runs continuously on crushed steel chips; the other alternates on cast iron borings and steel chips. Average analysis of salvaged cast iron borings remains constant with silicon content averaging 1.75 per cent and carbon 3.30 per cent.

The steel chips are first separated into alloy and non-alloy. Alloy chips are then separated into 13 classes according to analysis. Non-alloy chips are separated into heavy and light chips. Heavy chips are weighed up in cupola charges. Lighter chips are crushed at the rate of 10 to 15 tons per hr. Careful sorting of material is necessary to keep out tramp iron and foreign material.

Borings are dropped into the dies of the press, using hydraulic pressure of 1500 lbs. per sq. in. Maintenance of the press is low with the exception of the dies. The dies are hardened steel and are 4⅜ in. in diameter. The average life of a die is around 330,000 briquettes and costs about $400. The press averages 13 strokes a min.; this means 13 cast iron briquettes. They weigh 9-12 lbs. and have a density of 85-87 per cent of a solid piece of cast iron of the same weight. Cost of briquetting a ton of cast iron borings is about $1.90.

When briquetting steel chips, the presses are run without dust collectors and screen. Steel briquettes run 67 to 72 per cent in density compared with solid steel. Cost of briquetting steel chips is about $2.35 per ton.

At Allis-Chalmers three cupola units are used. Each unit has two pouring lines, one for soft and the other for base iron. Soft iron is used where the specification calls for ASTM 48-36 class 20.

A charge consists of: 15 per cent pig iron; 10 per cent bundles and flashings; 20 per cent steel briquettes; 17 per cent cast

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iron briquettes; and 38 per cent cast iron scrap.

The silicon and manganese balance is maintained by purchased briquettes. Chill depth is ¼ in. on the test block, and is controlled by SMZ alloy No. 2. This charge is used without any major change; only the amount of silicon or manganese briquettes are changed as variations in analysis occur. Chill test is poured from each ladle. The analysis of the base iron is as follows: Total C, 3.25 to 3.35; Si, 1.85 to 2.00; Mn, 0.85 to 1.00; and P, 0.10 to 0.16 per cent. Tensile strength is 35,000 lbs. per sq. in. on a 1.20 bar.

The castings are machined and checked for Brinell hardness. Steel in most mixtures, in addition to briquettes, contains bundles and flashings. Silicon sheets furnish a low carbon source of silicon and, as recovery is high, it is more economical to use them than to sell them. One base iron is melted in a cupola and used for tractor castings. The same amount of SMZ alloy No. 2 and carbon raiser are used as above.

The silicon and manganese balance is maintained with briquettes. Analysis is: Total C, 3.20 to 3.30; Si, 2.10 to 2.30; Mn, 0.85 to 1.00; and P, 0.18 per cent max. Tensile strength is 30,000 lbs. per sq. in. on a 1.20 bar. High test mixtures made up in 3000-lb. charges are as follows: 85 per cent briquettes; 10 per cent high test iron scrap and returns; and 5 per cent high phosphorus pig iron. It is melted with 2 per cent Si and inoculated with 40 points of silicon by SMZ alloy No. 2.

This iron with sections of 1 in. or under 1.25 per cent Ni was used to aid machinability. A copper-molybdenum-chromium combination produced strengths of over 80,000 lbs. per sq. in. Analysis of this iron was: Total C, 2.65 to 2.90; Si, 2.40 to 2.70; Mn, 1.25 minimum; and P, 0.10 per cent.

Oil on briquettes does not affect the analysis. Scrap losses when using briquettes are very low. Hot melting is important. At present market prices the use of briquettes is a definite saving.

—W. A. Hambley & Kenneth Geist, *Iron Age*, Vol. 150, Aug. 27, 1942, pages 39-42; Sept. 3, pages 60-63.

Making "Graphitic Steel" Castings

Condensed from "Foundry Trade Journal"

This was the American Foundrymen's Assoc. exchange paper read at the recent annual conference of the Institute of British Foundrymen.

The question of the proper material to be used to replace many steels, bronzes and aluminum parts is uppermost in the minds of many engineers. In recent years there has been a tendency in the motor vehicle field to replace certain forgings with castings. This has gradually followed through in other industries.

A versatile metal, known as "Arma-Steel," is referred to as a graphitic steel, since the matrix closely resembles that of a spheroidized steel. It is made from white cast iron of the following average analysis: C, 2.65; Si, 1.35; Mn, 0.40; S, 0.13; and

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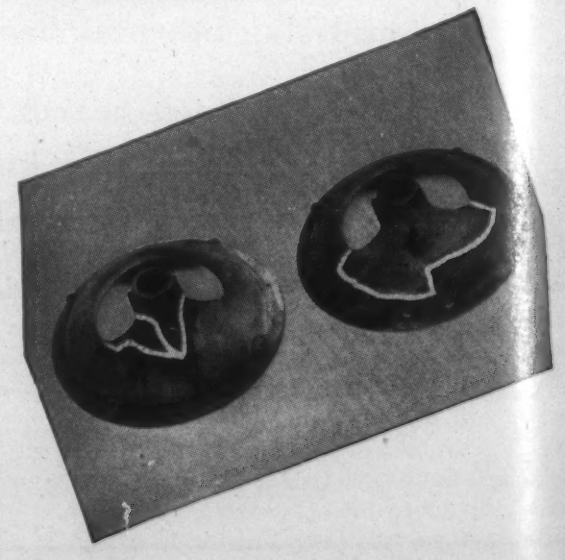

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P, 0.05 per cent. The metal is melted in a cupola and refined and superheated in an electric arc furnace.

Heat Treatment

The heat treatment of the white-iron casting is one of the most important operations in the production of Arma-Steel. The surface structure of the casting must be free from decarburization; therefore, close control of the furnace atmosphere is necessary. A number of radiant tube furnaces fired with natural gas are used for heat treating.

The castings are brought up to 1750 deg. F. and held for the required time to remove all massive carbide, which is around 15 hrs. The castings are cooled to 1598 deg. F. and air or oil quenched. This is followed by a tempering treatment to improve machinability and control physical properties. A tempering temperature of 1247 deg. F. for 4 to 6 hrs. will produce castings of approximately 197-241 Brinell hardness.

The development of the art of grinding opened the industrial door to hard Arma-Steel. A good example is the flame-hardened Arma-Steel camshaft of today. The hardened cams are rough and finish ground instead of rough machined as in the past.

Melting Equipment

The melting equipment used by various manufacturers in the production of sorbitic or graphitic steels is not as important as the raw materials going into the charge. Most manufacturers use pig iron and steel in the charge. Those using the duplex process use cupolas as the melting medium.

Microscopic examination of the pig iron is a routine test of the greatest importance. It was found that the iron will anneal with difficulty when large amounts of steadite are present. Steadite in even small amounts is undesirable in pig iron to produce castings for short-cycle malleableizing.

Since Arma-Steel parts in many cases are highly polished, it is extremely important that the castings have small temper-carbon spots. Large carbon spots adversely affest the machinability.

A study of the graphite size in pig iron is of the utmost importance, as it directly affects the carbon spots of the castings. There is a definite tendency to coarsen the primary graphite on more slowly cooling through the solidification range. The rate of cooling after solidification has no effect on the coarseness of graphite.

Some work has been done to determine the effect of graphite size in pig iron produced by casting metal into both copper and steel molds. Pig iron cast in a copper mold shows a sounder iron, in which the graphite flakes are much finer than the same iron poured into a steel mold.

Close Control in Production

The production of Arma-Steel requires much closer control and inspection than ordinarily given in the foundry industry. Magnaflux operations are performed on certain castings which, due to their design, are prone to crack. Arma-Steel replaced aluminum for piston material. At present motor-car and Diesel engines are successfully operating with pistons made from this material.

Machinability of Arma-Steel is from 10 to 30 per cent better than steel forgings at the same Brinell Hardness. The excellent damping characteristics are exhibited in many parts, such as the camshaft. It has a high yield ratio.

One of its most valuable properties is that the metal responds readily to localized hardening. Arma-Steel has a hardenability similar to low alloy steels, and is suitable for full hardening up to ¾ in. dia. when oil-quenched, or 1½ in. dia. when water-quenched.

—Carl F. Joseph, *Foundry Trade J.*, Vol. 67, Aug. 20, 1942, pages 365-369; Aug. 27, pages 387-389, 397; Vol. 68, Sept. 3, pages 11-15.

High-Pressure Iron Castings

Condensed from "Foundry Trade Journal"

A typical high-pressure iron casting is discussed by three authors in detail as to its manufacture and quality. The casting chosen is not a large or intricate one and it is discussed from the following angles: (1) The drawing, (2) design, (3) specifications, (4) conditions under which the casting has to work (pressure, etc.).

Because the cylinder cover is used in a machine compressing hydrogen to a pressure of 900 lbs. per sq. in., an essentially

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[redacted] has a Navy contract to assemble small brass parts for a certain piece of radio equipment. To remove the black and red scale formed during welding they were using wire brushes and steel wool, then buffing.

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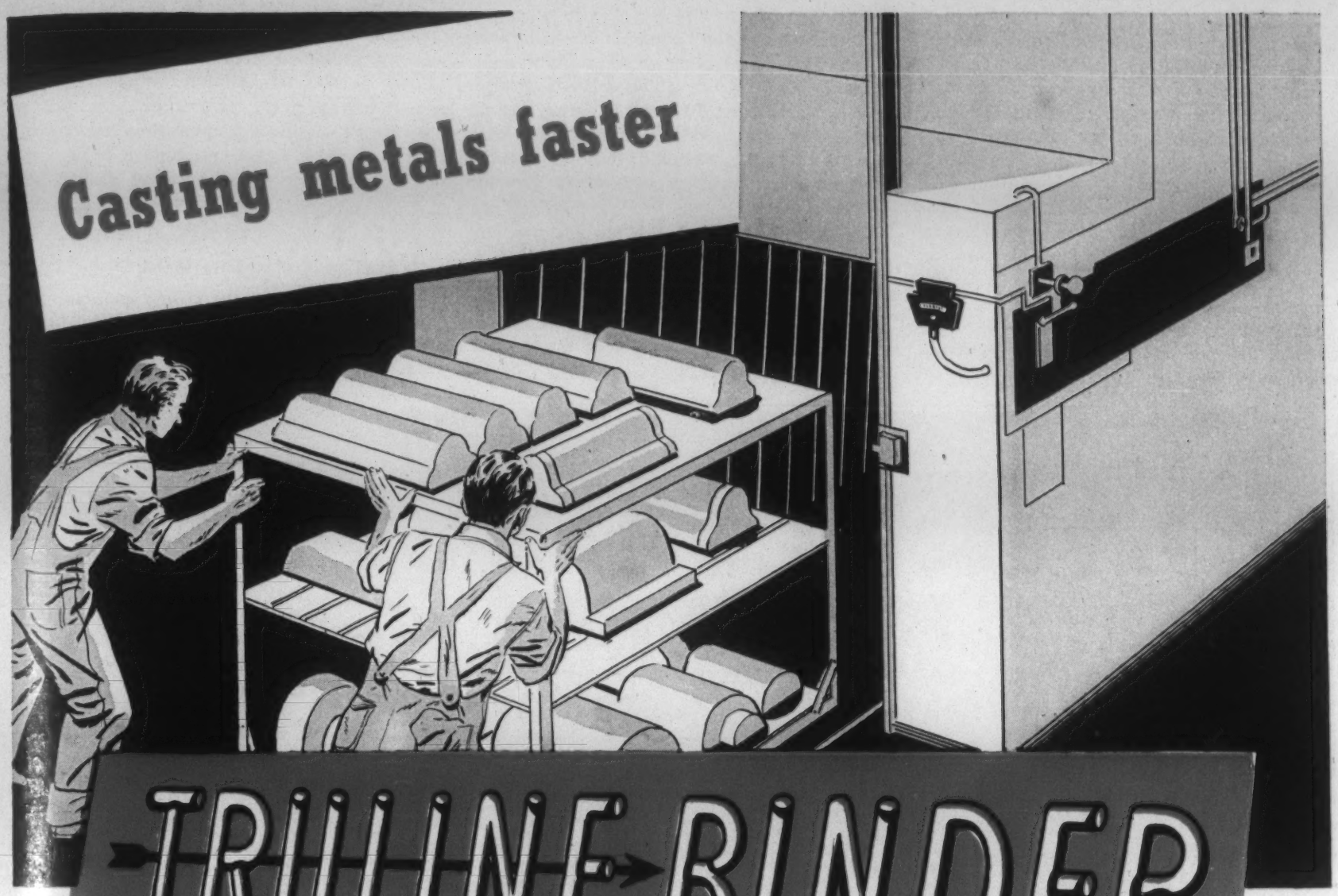

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sound casting is necessary. It is imperative that the hydrogen must not leak into the water spaces, and the suction and delivery holes must not leak into one another; also, the fact that hydrogen leaks through porous places much more readily than air makes it necessary to put this casting under a very strict test.

When the machining has been completed, full inspection is made to ensure no signs of open or coarse-grained sections of metal, and the two valves and valve holes are put under a water-test pressure of 2000 lbs. per sq. in. If this is satisfactory, the water jacket is subjected to a hydraulic pressure of 50 lbs. per sq. in., the two tests being carried out separately.

Machine Molding

A brief outline is given as to what pattern equipment and methods would be used for machine molding, with a "high-duty" iron. The following charge is suggested: 33.3 steel scrap; 29.1 remelt iron and 37.5 per cent pig iron (containing: 3.7 total C; 2.9 to 3.0 Si; 1.0 Mn; 0.03 per cent S.) Seven pounds of carbon-silicon per ton would be added as an inoculant. This mixture yields the following composition: 3.0 to 3.1 total C; 2.0 to 2.2 Si; 0.6 Mn; 0.085 Si max.; and 1.15 per cent Cu.

The requirements are that the castings shall not leak under a hydraulic test of 2000 lbs. per sq. in. applied to the suction and delivery valve pockets separately. The metal sections vary considerably, and porosity troubles can be expected in the thickened sections.

A suggested specification for molding sand is that it should be of the synthetic type, carrying a permeability of 40, a strength of 6.5 and a moisture content of 5 per cent. For the core sand it is suggested that this should be an oil sand carrying 3 per cent oil and yielding a permeability of 150.

Production in Meehanite Metal

It appeared that the critical point of the casting would be somewhere in the metal sections surrounding the valve and jacket cores. For the two castings two sets of cores were made from an oil-sand mixture, but one set had incorporated in it 12 per cent of cast-iron borings, while the other was constructed of silica sand and oil binder. The borings were passed through a 1/8 in. mesh sieve before mixing into the sand.

Preliminary tests were conducted on these two sands by casting two bushes having the core in one of the plain oil sand, while that in the other was made from the sand in which the borings had been mixed. The bush having the oil-sand core gave a Brinell reading of 227, while the other gave a value of 245.

The metal used was grade "C" Meehanite, containing 40 per cent steel scrap of chemical analysis: 3.11 C, 1.04 Si, 1.07 Mn, and 0.16 per cent P. Microscopic examination indicated that the Meehanite casting was sound and free from large scale porosity.

—*Foundry Trade J.*, Vol. 67, July 23, 1942 (A. F. Hammond) pp. 287-288, 292; Aug. 13, 1942 (S. E. Slater) pp. 351-353, 34[illegible]; Aug. 20, 1942 (J. King) pp. 371-372.

HAUSFELD

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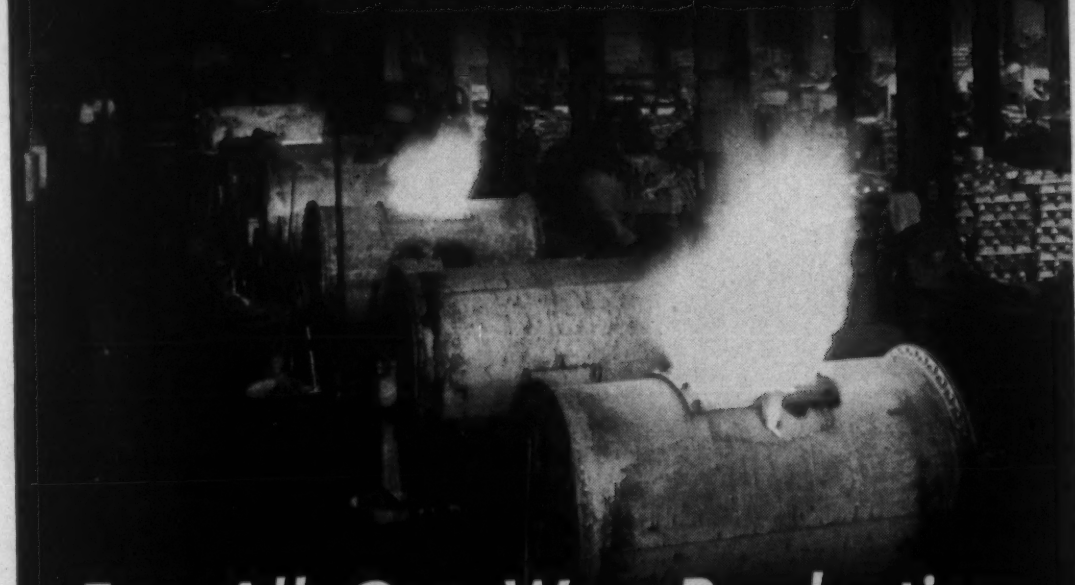

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200-220 MOORE ST. HARRISON, OHIO

Reclaiming Copper from Clad Steel Scrap

Condensed from a War Metallurgy Committee Report

Clad steel scrap from bullet jackets is accumulating at the rate of 1200 tons a month. By May of 1943, 20,000 tons monthly is predicted. The cladding contains 90 per cent copper and 10 per cent zinc and is approximately 20 per cent of the weight of the material.

The War Metallurgy Committee of the National Academy of Sciences has made a survey of the problem of recovery.

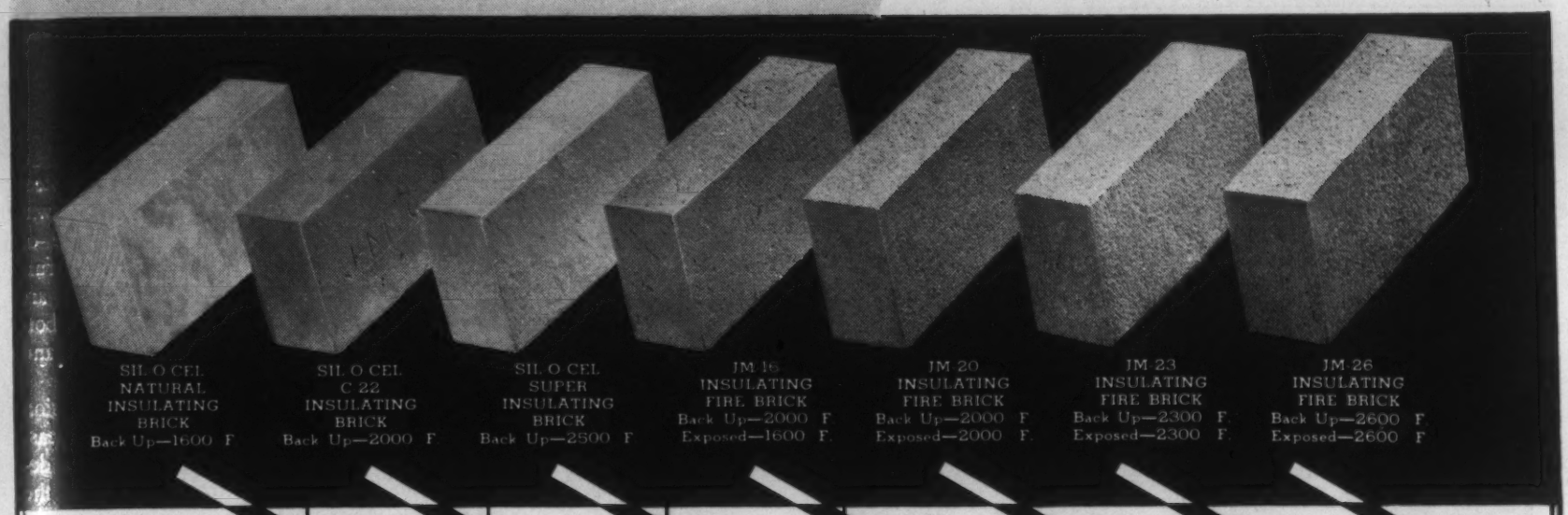
A standard leaching procedure as applied to copper ores, based on the solvent action of cupric ammonium carbonate on copper and zinc, has been shown to be workable. It is cheap and efficient and allows almost complete recovery of the copper and iron; the copper in the form of the oxide and the iron as unattacked scrap. Recovery of zinc depends on subsequent operations.

Electrolytic and scaling processes also considered have not been developed past an experimental stage and so far prove more expensive and have less satisfactory results.

The Calumet and Hecla Consolidated Copper Co. at Lake Linden, Mich. has capacity to treat 2500 tons per month of gilded steel, processing the copper to fire-refined bullion. They have an additional

THE *RIGHT* BRICK for EVERY TEMPERATURE ...for EVERY SERVICE

Listed below are details on the properties of the new complete line of J-M Insulating Brick and Insulating Fire Brick. Each is designed for a specific temperature and service . . . can be relied upon for continued efficiency and economy. For further details, write Johns-Manville, 22 East 40th Street, New York, N. Y.



Properties							
Density—lb. per cu. ft.	30	38	40	22	31	38	44
Transverse Strength—lb. per sq. in.	140	115	90	70	100	135	150
Cold Crushing Strength—lb. per sq. in.	400	700	300	70	125	170	165
Linear Shrinkage—%	1.4 @ 1600° F	0.8 @ 2000° F	2.0 @ 2500° F	0.0 @ 2000° F	0.0 @ 2000° F	0.0 @ 2300° F	0.5 @ 2600° F
Reversible Thermal Expansion—Percent	0.1 @ 1600° F	0.7 @ 2000° F	1.29 @ 2000° F	0.5—0.6 @ 2000° F	0.5—0.6 @ 2000° F	0.5—0.6 @ 2000° F	0.5—0.6 @ 2000° F
Conductivity at Mean Temperature	∥ ⊥						
500° F	1.01 .67	1.67	1.70	.75	1.01	1.26	1.61
1000° F	1.13 .79	1.88	1.95	1.01	1.19	1.49	1.90
1500° F	1.24 .90	2.08	2.19	1.41	1.49	2.05	2.61
2000° F	... ..	...	2.45	...	1.91	3.37	4.29
Recommended Service							
Back Up	1600° F	2000° F	2500° F	2000° F	2000° F	2300° F	2600° F
Exposed	....	....	....	1600° F	2000° F	2300° F	2600° F
Recommended Mortar for Setting Brick	Sil-O-Cel Mortar	Sil-O-Cel Mortar	Sil-O-Cel Super Brick Mortar	J-M No. 1626 Cement	J-M No. 1626 Cement	J-M No. 1626 Cement	J-M No. 1626 Cement

Note:—1. Above tests are in accordance with ASTM tentative standards.
2. Conductivity is expressed in Btu. in. per hr. per sq. ft. deg. F. at the designated mean temperatures.
3. ∥—with heat flow parallel to brick strata.
⊥—with heat flow perpendicular to brick strata.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville
INDUSTRIAL INSULATIONS

capacity of 7500 tons monthly for leaching of bi-metal scrap but oxidizing equipment for the additional material would have to be built. They have smelter capacity to handle the resulting copper oxide from 20,000 tons of gilded steel per month, but the shipment of oxide is a serious problem. A recovery plant for the zinc could be installed.

The Copperweld Steel Co. is training men in the operation of the ammonia process. The American Metal Co. also has men experienced in ammonia leaching.

Although from the standpoint of transportation the Cleveland or Pittsburgh area is the best location, Calumet and Hecla are in the best position to carry on the work. It is recommended arrangements be made for them to treat up to 2500 tons per month. Increasing their capacity should be considered.

So far as possible, the copper and zinc oxides should be treated for metal recovery in existing plants.

In addition to the scrap made in the production of blanks for bullet jackets, about an equal amount needs to be collected from the fabrication plant.

A rough estimate presented by the American Metal Co. shows the cost of operation (exclusive of amortization) to be $5.21 per ton treated. This applies only to the production of the oxides of copper and zinc.

Copperweld Steel, basing costs on a 21,500 ton per month plant to turn out clean baled steel scrap and mixed copper and zinc oxides, estimates a cost of less than $3.00 per ton, which is probably too optimistic.

Estimated recovery of steel is 100 per cent; of copper 96.5 per cent. The amount of zinc would depend on subsequent treatment. It will probably have to depend on that obtained as flue dust in the smelting of the mixed oxides. In this way a recovery of 82.5 per cent of zinc, as impure zinc oxide has been estimated.

—*Res. Report No. 7, War Metallurgy Committee,* Natl. Acad. of Sciences to WPB, Sept. 25, 1942, 13 pages.

Temperature Distribution in Various Steel-Making Furnaces

Condensed from "Blast Furnace and Steel Plant"

Temperature distribution in liquid steel under typical steel-making conditions was investigated. Observations were made of 40-ton and 25-ton acid open-hearth furnaces; a 12-ton 3-electrode Héroult arc furnace; 3-ton and 30-cwt. 2-electrode, bottom-return basic electric arc furnaces; and a 100-lb. high-frequency furnace.

The Schofield-Grace quick-immersion technique was used for temperature measurement. It is particularly suited to determining temperature variations in the melting-furnace. Since the platinum/platinum-13%-rhodium thermocouple is inclosed in a very thin silica sheath it takes up very rapidly the temperature of the surrounding metal when moved from point to point in the bath.

Whenever possible, observations were taken at a uniform depth at points distributed over one-half of the bath, and at different depths at one or more points in the bath. Temperatures were measured at stages in the steel-making process likely to yield extreme results or at times considered significant for the purpose of control.

The results of the temperature surveys are presented in diagrams.

The observations show that during the period when the bath is on the boil, the temperature is very uniform. This uniformity persists in the acid open-hearth furnace even when the activity of the bath is very low and the bath is approaching equilibrium. The degree of uniformity will depend on the activity of the bath and during the boiling period will vary between ±2 deg. and ±5 deg. C.

When the bath is killed and quiescent, greater temperature gradients begin to build up. The vertical gradient appears to be about 10 deg. C. per ft. in the acid open-hearth furnaces and the maximum horizontal variation at a constant depth is about 15 deg. C. The horizontal variation seems to be less regular and may partly be caused by the distribution of cold additions and by the form of the gas flame.

In the basic arc furnaces, the vertical gradient tends to become considerably greater than in the acid open-hearth furnaces and is kept within reasonable limits only by frequent rabbling. The usual degree of rabbling keeps the gradient down to about 10 deg. C. per ft. in the upper

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Writes one user (the operator of a brass foundry producing valves and steam specialty pressure castings), "We have for a number of years kept accurate figures on our metal losses with our Detroit Furnaces . . . and found consistently that the loss during melting is between 0.4% and 0.5%."

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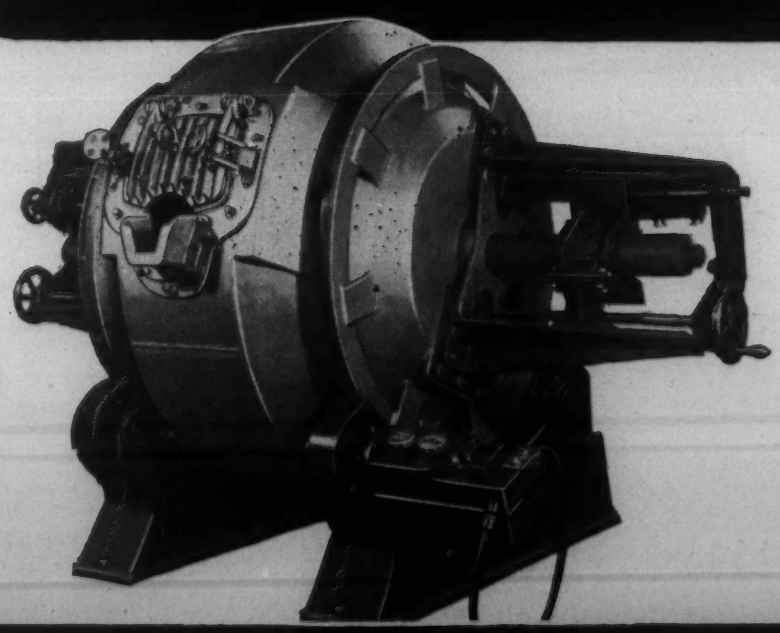

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2. Leaves no residual metal impurity, since it is itself insoluble.

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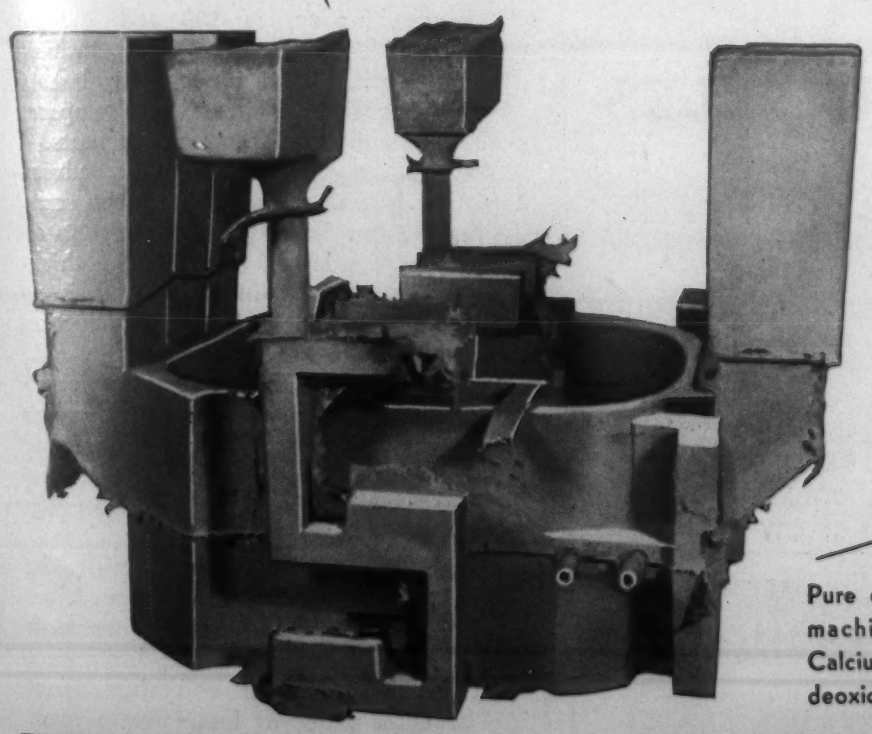
4. Reactive at normal operating temperatures and, therefore, does not require excessive super heat.

5. Does not affect the fluidity of the metal.

Calcium Boride contains no critical or strategic elements and is, therefore, not under W.P.B. allocation. It is, consequently, specified today more than ever to replace critical materials formerly used for the same purpose.



Pure copper casting for welding machine transformer. Electro's Calcium Boride was used as the deoxidizer.

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layers, although temperature differences of more than 50 deg. C. may be encountered near the furnace bottom.

Therefore, if a suitable place is chosen for taking a single observation of the bath, the results obtained will not usually differ by more than 10-15 deg. C. from the true average temperature of the steel.

Owing to thermocouple effects and unavoidable errors of observation, there is a further possible error of ±5 deg. C. Thus, the final absolute error may approach ±20 deg. C. but in most normal cases the error is likely to be of the order of ±10 deg. C.

This degree of accuracy is satisfactory for most cases, although there may be occasions when it will be advisable to make several measurements at two or more places in the bath.

—D. A. Oliver and T. Land, *Blast Furnace & Steel Plant*, Vol. 30, Sept. 1942, pages 997-1002.

Ore for Low-Scrap Open Hearth Practice

Condensed from "Blast Furnace Steel Plant"

In open-hearths using ore, the metal charge consists of 30 to 35 per cent scrap, 55 to 60 per cent pig iron, and 10 per cent iron ore. Addition of ore makes possible the oxidation of the greater amounts of silicon, phosphorus, manganese and carbon from the molten pig iron in a given time; permits larger proportion of pig iron to scrap; and results in flushing away of much of the metalloids in the initial slag, less tap slag volume, savings in limestone and fuel, and shorter time of heat.

The disadvantages of the ore process are more variation in final slag composition, more care necessary in working the heats, more danger to the operator with wet ores, and decreased furnace life.

The chief factors in selecting the charge-ore are maximum iron content to save shipping costs; minimum moisture content (because this must be eliminated completely before the hot metal can be added); minimum contents of acid slag-forming elements, silicon, phosphorus, sulphur and titanium oxides, as these have various drawbacks; magnetic materials, such as magnetite concentrates or sinter made from either magnetite or hematite, which can be handled by a magnet, saving much labor; and most important, freedom from fine particles and dust, because they shorten the furnace campaign life.

Types of Ore

Hematite ore may be screened and used either as lumps or fines. Hematite lump ore made by screening out fines makes a good charge-ore but as only limited quantities are available it should be reserved for use as feed-ore in working down carbon.

Fine hematite ore, mixed with fine coal or coke breeze and sintered, contains very few fines and little moisture and corresponds closely to the dry composition of the ore. Hematite flue dust contains enough fine carbon to sinter itself plus some additional fine ores. Sinters thus made are high in silica and fairly low in iron but are magnetic and otherwise similar to sinter made from magnetite ores.

A variety of ores has been used, alone or in combination, in 100 and 200-ton capacity open-hearth furnaces for making forging grade steels, during the last 6 yrs. The quality of these heats compares favorably with similar scrap-type heats.

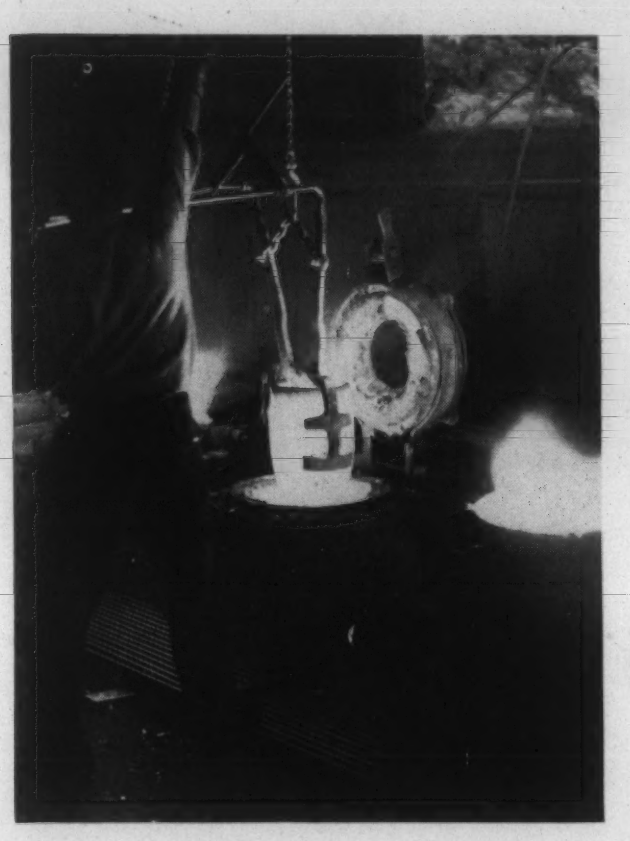
Ore charges show much greater advantages in increased production over scrap in the 200-ton heats than in the 100-ton heats. In the larger furnaces, the thickness of slag blanket in scrap heats is so great that heat penetration and production are slowed up to a greater extent.

The magnetite ores, coarse ore (sinter) is consistently better than medium coarse ore (coarse concentrates) or fine ore (fine concentrates or sinter), indicating that dust in these ores is deleterious to furnace life and production.

With hematite ores, there seems to be little difference between coarse ore (flue-dust sinter, lump ore) and fine ore (soft ores). In most cases, however, heats were charged with soft ore and then about half as much sinter or lump ore to cover it up, thus reducing the tendency for fines to blow away.

Magnetite sinter is the best of all ores in both sizes of furnace. Coarse and fine hematites are somewhat better than coarse magnetite concentrates and much better than fine magnetite concentrates.

—R. W. Tindula *Blast Furnace Steel Plant*, Vol. 30, July 1942, pp. 763-768.



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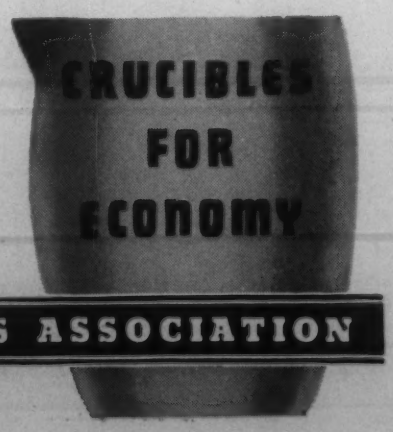
Note how the tongs in the illustration fit the crucible: note also the long broad blades. *Make Sure Your Tongs Fit the Crucibles.*

OTHER AIDS TO CRUCIBLE LIFE

1. Unpack carefully.
2. Store crucibles in a dry warm place.
3. For the first heat follow the instructions of the manufacturer of the particular type of crucible you are using.
4. Charge ingots or long pieces so they will not wedge and rupture the crucible when expanding.
5. Empty the crucible on the last heat of the day.
6. Be careful in the use of stirrers or pokers for coke fires.
7. If you use coke fires avoid pinching coke between tong blades and crucible: scrape coke from bottom of crucible before setting down in shanks.
8. If oil or gas are used keep proper ratio of fuel and air; the flame should be neutral or only slightly oxidizing or reducing.

FOR COMPLETE AND DETAILED INSTRUCTIONS WRITE FOR BOOKLET TO THE ADDRESS BELOW



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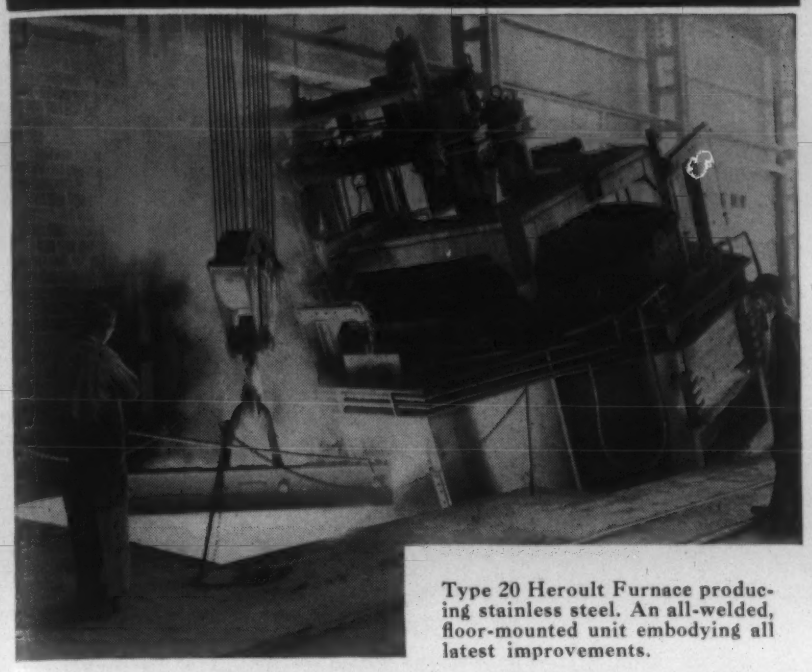

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Nickel Aluminum 20-80 in Slabs

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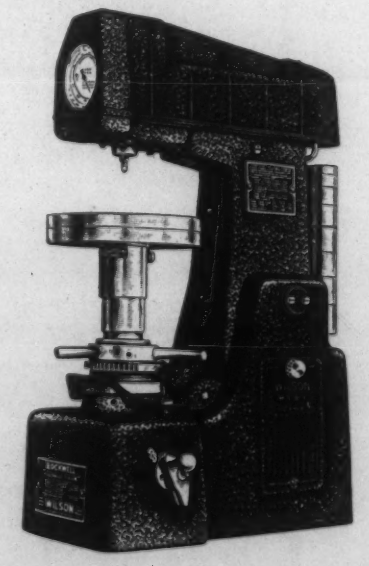

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Anodizing in Chromic Acid

Condensed from "Products Finishing"

This article is concerned with the practical operating aspects of anodizing rather than with the theoretical aspects. The following equipment is needed for the anodizing cycle:

(1) A steel cleaner tank equipped with heating facilities, water inflows, drainage and ventilation;

(2) two steel rinse tanks, one equipped with cold water inflow and drainage, and one equipped with heating facilities and preferably ventilation;

(3) a steel tank for the chromic acid anodizing solution, equipped with adequate ventilation facilities, steel heating and cooling coils, and an air line for agitation. Tap water is sufficient coolant. The entire tank is cathodic and an anodic work rod is provided. The tank and coils should be protected from short-circuits by reinforced glass strips suitably supported.

For a current source a motor generator set is recommended, but rectifiers may be used. A 0-48 volt, 1500 ampere set is sufficient for a 3 x 6 x 12-ft. tank. Normal current density is about 1 to 7 amp. per sq. ft., but surge values may be 4 times as high; current capacity must be sufficient to accommodate these surge values. For Government specification work, recording voltmeters and thermometers are required. In addition an ordinary voltmeter, ammeter, etc., are necessary.

Any suitable aluminum cleaner may be used. The cleaner solution is operated at 170 to 200 deg. without current; 10 to 20 min. immersion is usually sufficient. The anodizing solution is a 5 to 10 per cent solution of chromic acid, operated at 91 to 99 deg. F. Reduced chromium, aluminum and ferric oxides, and chloride must be maintained below specified limits.

The anodizing cycle consists in racking, cleaning, rinsing, anodizing, rinsing in hot water, and unracking. During anodizing the voltage is increased from zero to 40 or 48 volts in 5 volt steps at 1-min. intervals. Treatment is continued at the final voltage for at least 30 min.

Racks and wires are made of aluminum, since brass or copper dissolve in the bath and contaminate it. The anodic coating formed on the racks must be stripped before re-use by immersing in a solution of 5 oz. per gal. of caustic soda at 150 to 160 deg. F.

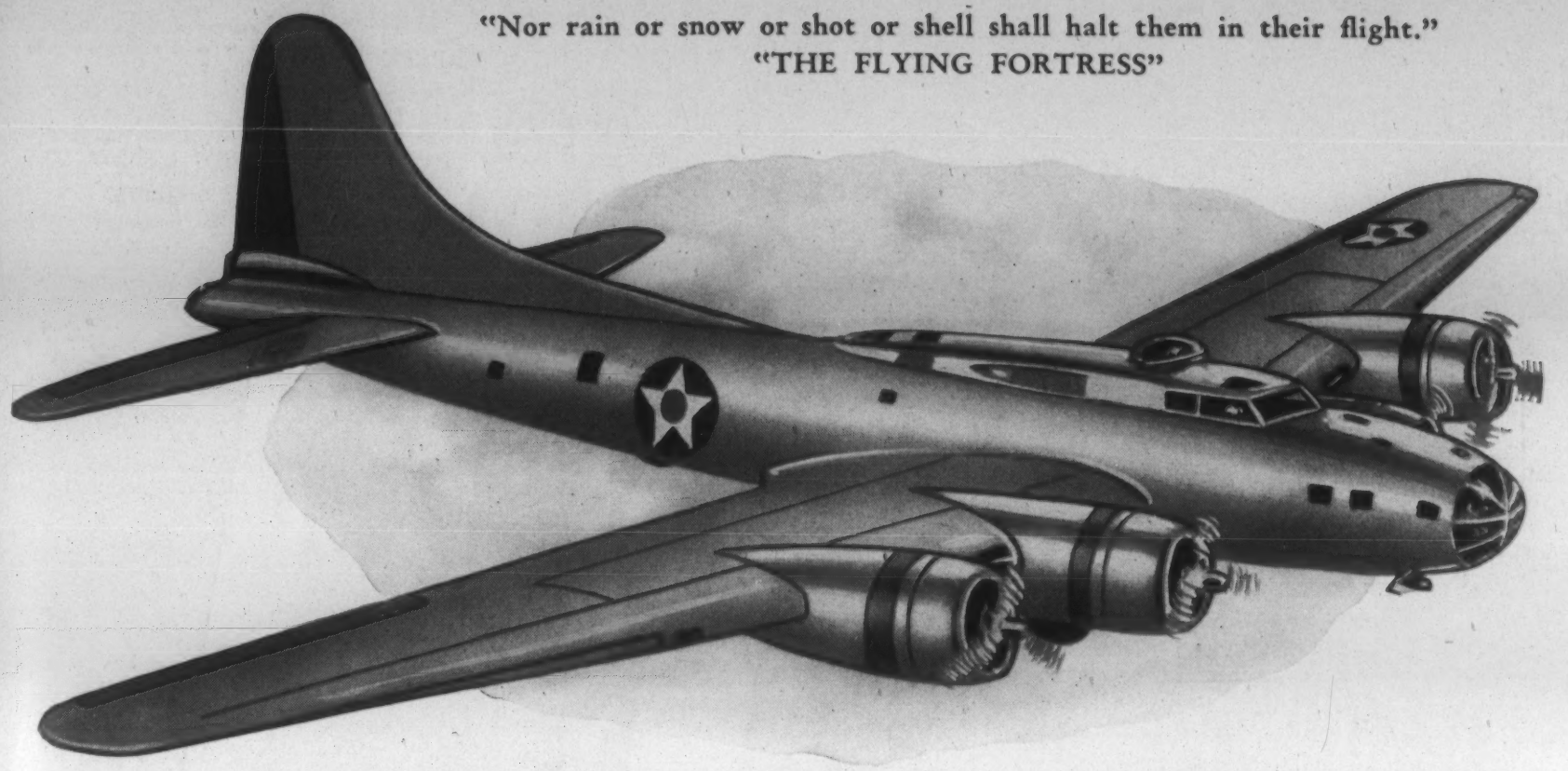
For the stripping operation, a steel tank equipped with ventilation is required. When the oxide film has dissolved, violent gassing starts. The racks are then rinsed and immersed in a 1 to 1 solution of nitric acid until any smut formed in the caustic dip is dissolved. The racks are then again rinsed.

Diagrams are shown of several general type racks and of a basket for holding small parts.

The quality of an anodic coating can be tested with an ink adhesion test, or by a simple conductivity test. Both of these tests are described.

An easy method of shop control of the anodizing bath consists simply in a check of the current density. If it is between 3.5 and 0.9 amp. per sq. ft., a good deposit

"Nor rain or snow or shot or shell shall halt them in their flight."
"THE FLYING FORTRESS"



America's Flying Fortresses are raising hell with the enemy.

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Our organization rejoices that every time an enemy plane tumbles out of the sky, hundreds and thousands of Sciaky victory welds are in the fight.

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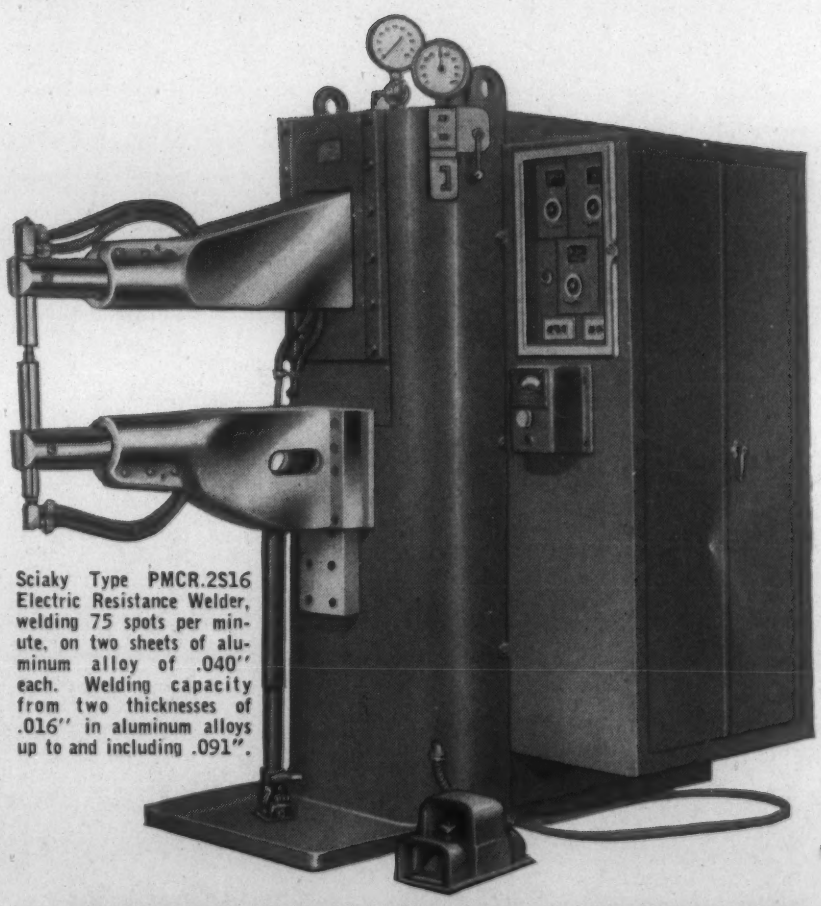

Sciaky Type PMCR.2S16 Electric Resistance Welder, welding 75 spots per minute, on two sheets of aluminum alloy of .040" each. Welding capacity from two thicknesses of .016" in aluminum alloys up to and including .091".

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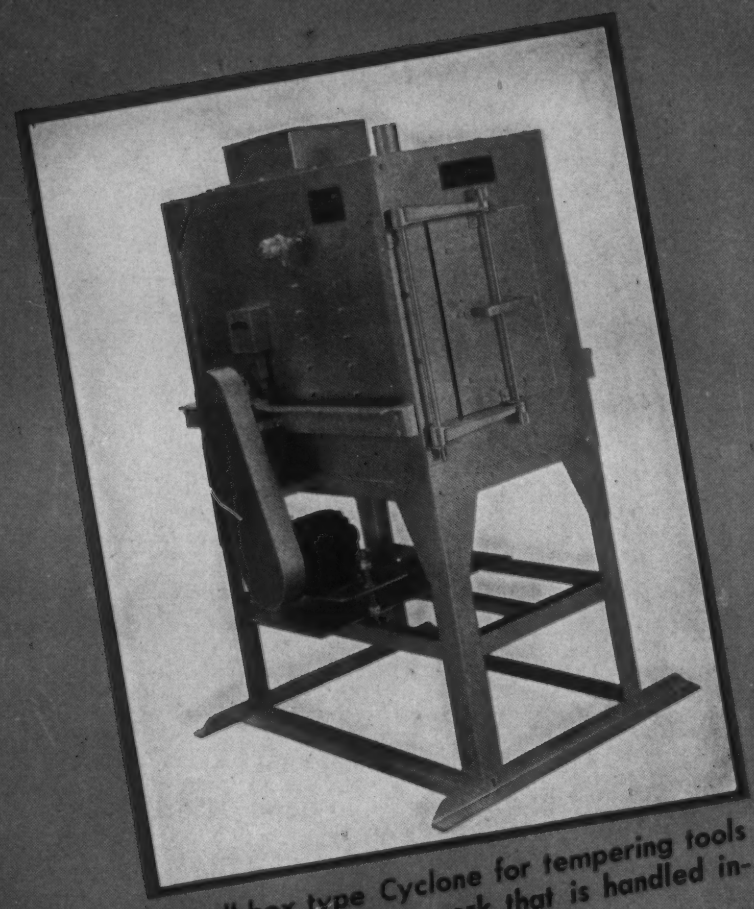
Large box type Cyclone for aluminum and magnesium heat treatment.



Small box type Cyclone for tempering tools and dies or other work that is handled individually.

Large vertical type Cyclone for production tempering. Its accuracy of heating and control also makes it ideal for aluminum and magnesium heat treatment.

Small vertical type Cyclone Furnace for heat treating small parts. Note basket in lower right hand corner.

The accuracy and uniformity of heating is consistent throughout the entire range of sizes

SPECIFY STANDARD SIZES when ordering heat treating equipment. Valuable time is saved because drawings are available and all engineering has been completed. Man hours are saved by the elimination of special work in both engineering and the shop. And heat treating furnaces are sped to their destination to do their chosen work.

The dimensions listed below represent standard sizes of both vertical type and box type Lindberg Cyclone Furnaces. Each of these furnaces has been engineered and built and installed in the field.

The sizes embrace a range wide enough to handle practically any heat treating job for temperatures up to 1250°F.

LINDBERG VERTICAL TYPE CYCLONE *FUEL FIRED*

Utilizes the famous Lindberg 100% forced convection heating principle, available in both fuel fired and electrically heated units. Work is handled in baskets or on fixtures for accurate, uniform, low-cost tempering and precision heat treatment of aluminum and magnesium castings and forgings. Temperatures from 250°F. to 1250°F.

Dia.	Depth	Dia.	Depth	Dia.	Depth	Dia.	Depth	Dia.	Depth	Dia.	Depth	Dia.	Depth	Dia.	Depth
12″	16″	16″	36″	22″	72″	25″	160″	28″	72″	38″	28″	43″	48″	60″	72″
12″	100″	22″	26″	25″	20″	28″	28″	33″	28″	38″	30″	43″	54″	72″	24″
16″	20″	22″	30″	25″	30″	28″	36″	33″	36″	38″	36″	48″	28″	74″	72″
16″	22″	22″	36″	25″	36″	28″	42″	33″	40″	38″	48″	48″	38″	74″	86″
16″	26″	22″	38″	25″	40″	28″	48″	33″	48″	38″	60″	48″	48″	100″	44″
16″	28″	22″	48″	25″	48″	28″	50″	33″	60″	38″	72″	48″	60″	—	—
16″	32″	22″	60″	25″	60″	28″	60″	33″	72″	38″	84″	48″	78″	—	—

ELECTRICALLY HEATED

Dia.	Depth	Dia.	Depth	Dia.	Depth	Dia.	Depth	Dia.	Depth	Dia.	Depth	Dia.	Depth	Dia.	Depth
8″	10″	16″	20″	22″	36″	25″	30″	28″	28″	33″	36″	38″	120″	48″	96″
8″	12″	16″	24″	22″	48″	25″	36″	28″	36″	33″	120″	43″	42″	60″	60″
10″	14″	16″	26″	22″	60″	25″	40″	28″	48″	38″	36″	43″	48″	60″	72″
10″	20″	16″	28″	22″	72″	25″	42″	28″	54″	38″	48″	48″	36″	60″	84″
12″	16″	16″	32″	22″	80″	25″	48″	28″	60″	38″	60″	48″	60″	60″	93″
12″	18″	16″	48″	22″	100″	25″	60″	28″	72″	38″	72″	48″	72″	—	—
12″	20″	22″	26″	25″	20″	25″	66″	28″	84″	38″	84″	48″	84″	—	—

LINDBERG BOX TYPE CYCLONE *FUEL FIRED*

Is also heated by 100% forced convection and is also available in both fuel fired and electrically heated units. Recommended for tempering tools or dies or other work that is handled individually. Its heating accuracy and control make the box type Cyclone ideal for heat treating aluminum and magnesium castings, stampings and forgings. Temperatures from 250°F. to 1250°F.

Width	Depth	Height	Width	Depth	Height	Width	Depth	Height	Width	Depth	Height
12″	16″	18″	24″	48″	18″	36″	36″	24″	48″	12′	60″
15″	24″	18″	24″	24″	20″	36″	54″	30″	54″	72″	36″
17″	24″	18″	30″	48″	40″	36″	72″	30″	60″	96″	42″
18″	36″	18″	30″	48″	48″	36″	72″	36″	72″	12′	42″
24″	24″	18″	30″	72″	24″	36″	92″	24″	—	—	—
24″	36″	18″	36″	22″	24″	42″	72″	36″	—	—	—

ELECTRICALLY HEATED

Width	Depth	Height	Width	Depth	Height	Width	Depth	Height	Width	Depth	Height
12″	16″	18″	24″	48″	18″	42″	14′	36″	52″	84″	20″
12″	12″	10″	28″	28″	36″	48″	60″	30″	60″	60″	42″
15″	24″	18″	30″	30″	24″	48″	66″	48″	60″	10′	42″
15″	24″	24″	33″	34″	30″	48″	72″	30″	60″	10′	60″
15″	30″	18″	36″	36″	24″	48″	72″	36″	60″	16′	60″
15″	48″	18″	36″	48″	24″	48″	72″	48″	66″	15′	66″
18″	36″	18″	36″	54″	30″	48″	72″	60″	66″	16′	76″
20″	24″	18″	36″	72″	24″	48″	96″	36″	66″	25′	76″
20″	30″	18″	40″	96″	24″	48″	10′	72″	72″	96″	84″
20″	36″	18″	42″	16′	36″	48″	12′	72″	72″	12′	42″
24″	24″	18″	42″	16′	66″	48″	16′	72″	84″	96″	72″
24″	36″	18″	42″	72″	36″	48″	18′	72″	—	—	—
24″	36″	30″	42″	84″	42″	48″	22′	66″	—	—	—

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Ebonol "Z" is being widely used for applying adherent, jet-black finishes upon zinc and zinc alloy surfaces. Finish is applied in from 3 to 8 minutes in a solution operating from 150 to 200°F.

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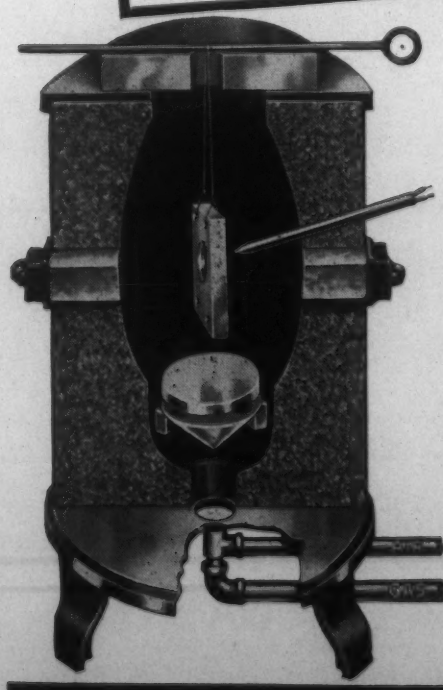

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is obtained. If the current density falls below 0.9 amp. per sq. ft., an addition of chromic acid should be made.

Another empirical procedure is the addition of 100 lbs. of chromic acid for each 35,400 amp.-hrs. of use. Measurements of specific gravity and pH also provide suitable control methods. Data necessary for use of the latter methods are given.

—Edward Finnie, *Products Finishing*, Vol. 6, Sept. 1942, page 10.

Should Steel Be Quenched from the Tempering Temperature?

Condensed from "Engineering"

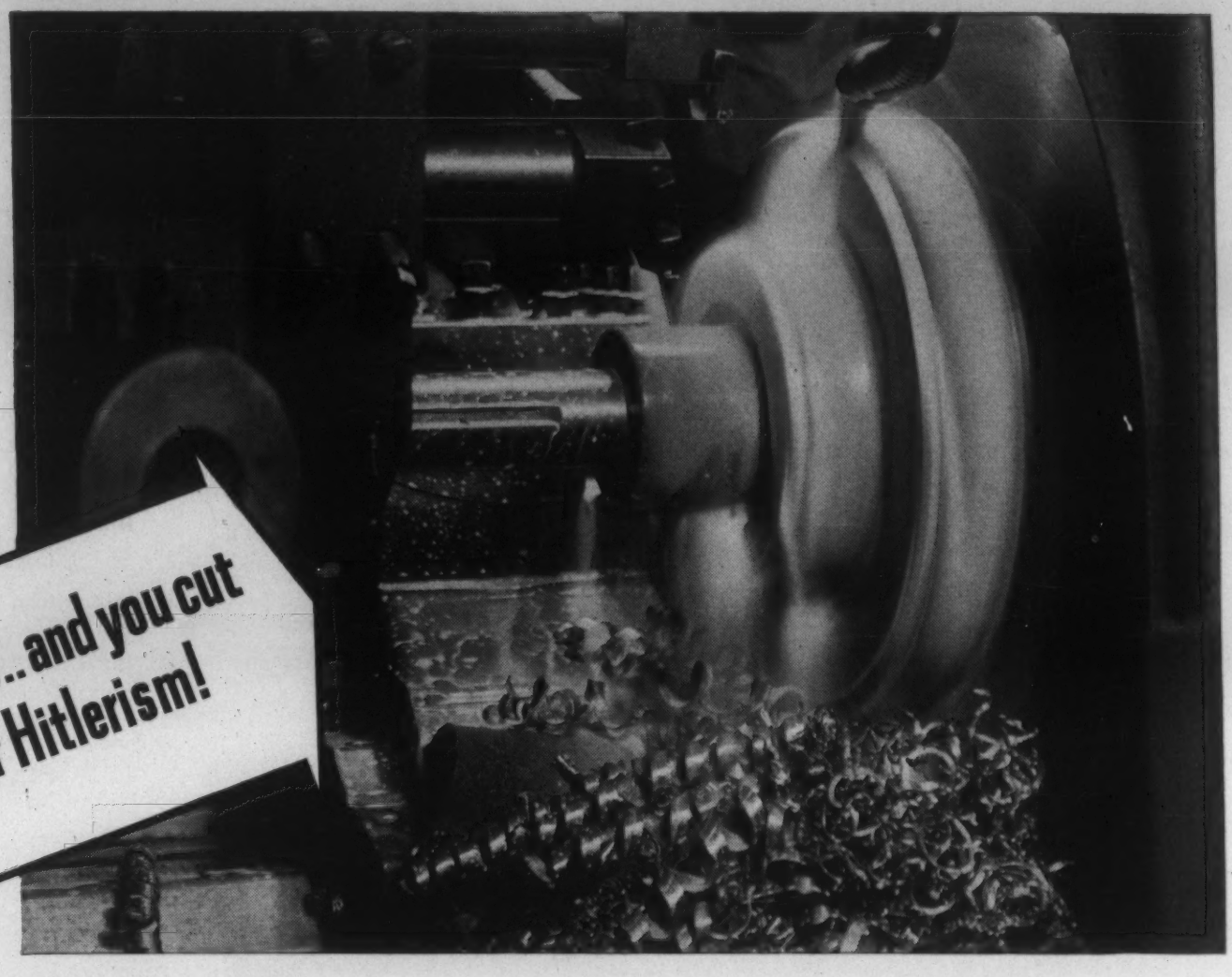
The author emphasizes the undesirability of quenching steel after tempering following hardening. Premature failure of several traction gear rims was attributed to internal stresses developed by this treatment. The rims had a face width of 5.25 in., mounted on centers, and had an inside diameter of 21.8 in. The chemical analysis was C, 0.34; Ni, 3.23; and Cr, 0.12 per cent.

At first the fatigue character of the primary cracks suggested that failure occurred through repeated over-loading, but this was not the case. In the first place primary fatigue cracks did not begin at a point near the top root of the radius, but occurred at the bottom of the root of the radius. Secondly the crack showed a tendency to spread through the gear rim in a nearly radial direction instead of at 45 deg. to radius as is usual in simple tooth overloading. It is indicated that abnormal tangential stresses had been an important factor in causing failure, and high stresses due to shrinking the rim on to the center were suspected.

It was ascertained that the rim and center had been oil hardened and followed by tempering at 1112 deg. F. and water quenched. Tests conducted showed that forced cooling after tempering may result in dangerously high stresses and that danger will increase with the mass of the section. Further experiments confirmed that for parts of similar section, air cooling after tempering is comparatively safe. Stresses set up by quenching after tempering are also responsible for trouble in machining owing to distortion which accompanies redistribution of stress on carrying out unsymmetrical machining.

This type of distortion may occur on structures other than gears. This applies to the parts machined from heat-treated parts as well as forgings and castings. This trouble is remedied by retempering at 1112 deg. F., followed by proper cooling — air cooling for small parts and furnace cooling for large ones. For ordinary engineering purposes, a high impact figure obtained on a small test piece has no real significance and is not essential for satisfactory service.

Exceptions must be made for certain applications which demand a high impact figure under normal testing conditions. They are parts with notches or sharp changes in section operating at low temperatures and parts operating for long periods at such high temperatures that progressive embrittlement occurs. For this purpose suitable



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- ☐ Cold Spray Cleaning
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steels are available. For more ordinary work an Izod test of about 5 ft. lb. to 10 ft.-lb. is sufficient.

The author's opinion is that quenching after tempering may be very dangerous for general engineering purposes; it would be of benefit if all specifications calling for this treatment, either directly or indirectly, were modified so as to prohibit it; from the point of view of distortion on machining alone, it would be of substantial assistance to the war effort.

—L. E. Benson, Engineering, Vol. 154, Aug. 14, 1942, pages 134-135.

Induction Hardening Saves Alloy

Condensed from "Steel"

Even before the present shortage of alloy steels, the author's company sought to use plain-carbon steels for various parts. Attention was first directed to the use of induction hardened carbon steels as a substitute for carburized and hardened alloy steels in gears. It was found that a part made of SAE X-1340 steel can be induction hardened to required properties just as satisfactorily as if it were made of SAE 2315 or 3115 and case-hardened.

Induction hardening has led to a number of economies, but the most important gains result from the elimination of certain operations. For example, in producing a gear from SAE 3115 after teeth were rough cut, it was necessary to carburize, finish cut teeth, harden, draw, clean, and lap. Now when SAE X-1340 is used, it is necessary only to rough cut the teeth, shave, and induction harden.

The fixture for hardening this gear consists of a copper-tube induction-coil that surrounds the gear with a clearance of 1/8 in., outside of which is a quench ring parts, some thickness or size is added to with many small holes for passage of water under pressure. A brass stud in the center of the fixture centralizes and locates the gear in proper relation with the induction-coil. Heat cycle is 12 sec. and quench, 8 sec.

Formerly, many gears were heat treated to a hardness of 28-30 Rockwell C. They were usually made from heat-treated bars or blanks, all manufacturing operations being done with the material in the heat-treated condition. Now, untreated bars or blanks are used, the gears being hardened after completion to a hardness of 50-50 Rockwell C. Parts are made with a generous margin of safety.

Another factor influencing the adoption of SAE X-1340 is its machinability. From machinability tests in which SAE 1112 is rated 100 per cent, SAE X-1340 has a rating of 90 per cent; SAE 1040, 75 per cent; SAE 2340, 60 per cent; SAE 4140, 60 per cent; SAE 3140 at 280 Brinell, 40 per cent; and SAE X-1340 at 270 Brinell, 60 per cent. A great many machine parts are now made from SAE X-1340 and virtually no alloy steels are used.

Another example of satisfactory substitution is the use of SAE X-1315 instead of SAE 3115 for machine spindles. For some certain sections in changing to carbon steels

—Frank W. Curtis, *Steel*, Vol. 111, Aug. 3, 1942, pp. 73-74, 76, 112-113.

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Wide variations in shape, size and alloy content are permissible. About the only requirements are: (1) it can't be cast solid, a hole has to pass through the center; and (2) the wall thickness must be at least ¼ inch thick. Present facilities permit lengths up to 7 feet with 6⅝" O.D. and up to 13½ feet with larger O.D. Lengths, of course, can be welded together; also specially shaped, statically cast parts welded to the centrifugal casting.

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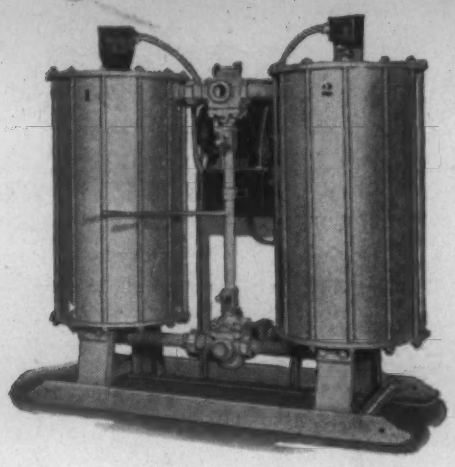

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This No. 2 Type "C" Horizontal Electric Heater is designed to develop heat in the piece that is to be soldered, to such temperature as is necessary to melt the kind of solder used. For example, if you want to solder a mercury tube to the gage body, the gage body would be placed between the electrodes of this BERWICK Heater, brought up to 350° if soft solder is being used, or to 1350° if silver solder is used. The same is true where discs are to be soldered in the ends of brass or other metal tubes . . . or where the brass, copper or other metal slugs on which threads are cut are to be soldered in the tubes or other articles. A cleaner, stronger soldered joint is secured.

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Fast Milling with Carbide Tools

Condensed from "American Machinist"

Watervliet Arsenal has developed a method of milling steel with sintered carbides to speed machining of steel forgings. The built up edge formed in milling is quite different from that formed in steady turning.

In milling, the built up edge is in pressure contact with the tool face. As the tool leaves the work, the built up edge is torn from the tool face and usually remains attached to the trailing end of the chip. This action rapidly develops pits in the face of the sintered carbide tip, with the result that chipping or spalling of the cutting edge occurs when the pitting approaches the edge.

Face mills of conventional high speed steel design have not been successful with sintered carbides. The successful milling of steel with sintered carbides has been made possible by the use of a cutter with both rake and helix angles negative. The negative rake strengthens the cutter, and shears the chip from the work, as well as materially reducing cratering and pitting of the tooth face and the wear and chipping of the cutting edge.

However, there is a tendency for the blade to be pulled out of the cutter so a positive method of locking the blade (such as tack brazing with an oxyacetylene torch) must be used. The high cutting speed used entails a high rate of chip formation and removal so there must be ample chip space in front of each cutting tooth.

The milling is carried out with a very light feed per tooth, frequently less than 0.0012 in. per rev., but the table feed is often six times that used with high speed steel cutters, giving a good finish and only slight temperature rise. The minimum cutting speed is three times that used with high speed steel (over 500 ft. per min. even on heat-treated alloy steel). Cutting is done dry.

Examples of milling practice are given showing savings in time or increase in production up to over 300 per cent. A 45-deg. corner champfer is used on the cutters. For best tool life, the tools should be honed after grinding. Chip formation at the slow speeds used for high speed steel is accompanied by severe deformation producing a tear type chip; while at the high speeds used with the carbide tools, a flow type chip is formed.

—E. G. Moffat, *Am. Machinist*, Vol. 86, Sept. 3, 1942, pages 933-936.

Selenium Rectifiers for Plating

Condensed from "Metal Finishing"

A specific installation of selenium rectifiers for electro-plating is described which illustrates the flexibility and ease of control of this type of power source. In chromium plating of some rather large parts, each part requires a current of 1800 amp. and a voltage up to 12 volts. Conditions which must be met are as follows:

(1) The thickness of the deposit must be accurately controlled.

(2) The voltage must be increased at regular intervals.

(3) Six parts are to be plated at one

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time in a common tank, with an independent power supply for each part.

(4) The power supply units must be equipped with necessary control and signal features which will make it possible for one operator to handle 6 pieces of work simultaneously without confusion.

(5) The use of minimum floor space is important.

The main power supply available is 440-volt, 60-cycle, 3-phase; 115-volt, 60-cycle, single-phase power is also available for signalling and auxiliary circuits.

Installation of 6 standard 1800 amp., 2-12 volt rectifier units, each equipped with voltmeter, ammeter, pilot lamp, monitor lamp and buzzer (overload warnings), automatic shutdown if overload warning is ignored, etc., fulfilled part of the above requirements.

A special ampere-hour meter was added to meet the other requirements. This meter is calibrated to 10,000 amp.-hrs. The ampere-hour indicator can be set to zero. A second pointer can be manually set to the desired number of ampere-hours. When the indicator reaches this position, an auxiliary circuit is closed which operates either a signal lamp or a buzzer, or shuts off the rectifier, thus stopping further plating.

A typical sequence of operations is as follows:

(1) At the start of the cycle, the ampere-hour indicator is set to zero and the pre-set pointer is set at 1000 amp.-hrs. The amperage is adjusted to the desired value.

(2) When the signal indicates 1000 amp.-hrs. have been reached, the pre-set pointer is set at 2000 amp.-hrs. and the tank voltage is increased to the second step value. This procedure is repeated as often as necessary.

(3) For the last step in the cycle, the pointer is set to the maximum number of amp.-hrs. desired, and the "shut-off" switch is thrown on.

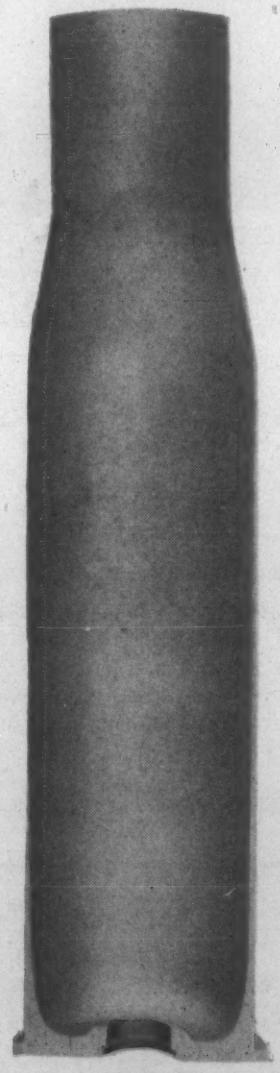
At the completion of plating the current shuts off and signals completion automatically. The use of six such semi-automatic units makes it easy for one operator to handle six parts simultaneously without shutting down the tank while loading and unloading, thus making it possible to operate the tank at nearly 100 per cent capacity all of the time.

—L. W. Reinken, *Metal Finishing*, Vol. 40, Sept. 1942, pages 470-471

DREI-BRITE PROCESS DESCALING

After Annealing

CARTRIDGE and SHELL CASES Steel Brass



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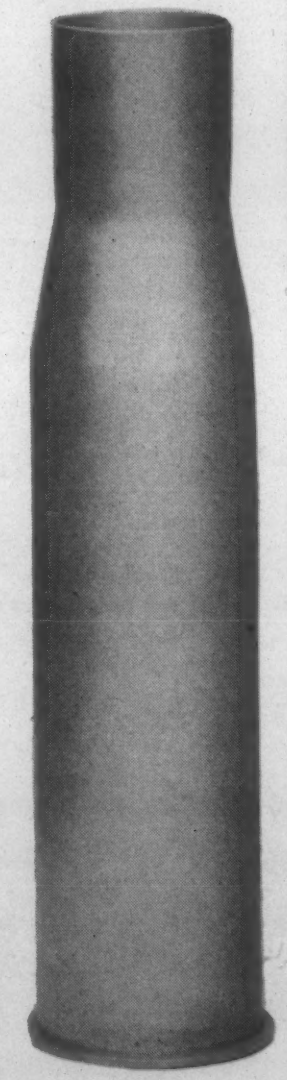

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REQUIREMENTS — LOW PERCENT OF CRITICAL MATERIALS IN CONSTRUCTION — OPERATION and • MAINTENANCE •

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Bronze Welding vs. Brazing

Condensed from "Sheet Metal Industries"

Bronze welding has greatly increased in popularity in the past 17 yrs. and has been found especially adaptable for maintenance welding (such as malleable castings where fusion welding is unsatisfactory), surfacing, welding of copper pipe, aircraft light-gage steel fittings, etc. Its advantages include the low temperature, reduced distortion, elimination of heat treatment after welding, ease and rapidity of operation, etc.

Brazing is the process of uniting metal with a modern "spelter" (usually about equal parts of zinc and copper) although today many brazing alloys contain no zinc.

Bronze welding is the process used for joining practically all commercial metals that have a melting point above 1450 deg. F. The rods are fundamentally 60 Cu, 40 per cent Zn with minor alloying additions, although some rods may contain 9-15 per cent Ni. [*Not in America today!—F.P.P.*]

Parts to be brazed should be fitted closely together; in bronze welding the filler metal alone provides the joint strength and close contacting faces and additional mechanical fastenings are undesirable. In bronze welding, the deposition of bronze is always preceded by a controlled tinning effect.

Bronze welding rods must be produced to a carefully controlled composition and must be deposited in accordance with certain strict requirements, while brazing may be varied to an amazing extent. Bronze welding rods can be melted by direct application of a concentrated heating flame and the deposit is built up layer by layer more like oxyacetylene welding.

Brazing alloys do not react favorably to direct application of a highly concentrated flame of the oxyacetylene type, which causes intense zinc volatization, weakness, and porosity. Brazing alloys are more effective when the heat is indirectly applied and the spelter drawn into the joint by force of gravity or capillary attraction.

Brazing permits a variation in composition and shape of jointing material, where-

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On U. S. Army tanks, the rims of the "bogie wheels" are brass-plated before their rubber "shoes" are put on. If the brass-plating is unsatisfactory, a poor rubber-coating job results.

A manufacturer had the problem of stripping unsatisfactory brass-plating from the tank rims. He was using a boiling chromic acid bath, but the job took an hour and entailed considerable evaporation of the acid. Since chromic acid is on priority, he wanted to speed up the operation in order to conserve this critical material.

A Penn Salt representative saw that a Pennsalt Cleaner could help. Result? The Pennsalt Cleaner stripped the brass in one-fourth the time formerly required, and cut down the time in chromic acid to *one-fifteenth*, thus effecting a substantial reduction in the chromic acid lost by evaporation. It did everything the customer needed, from a brass-removing standpoint, and subsequent re-plating of the rims was entirely satisfactory.

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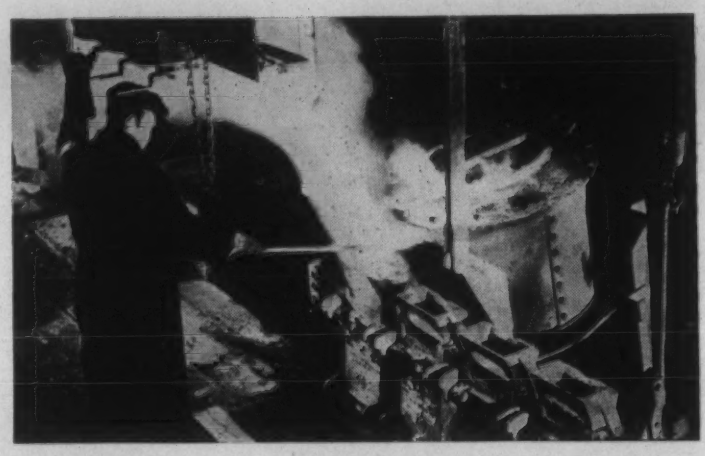
HOW THE WROUGHT BRASS INDUSTRY CONSERVES METAL



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as bronze welding almost always uses a rod of closely controlled composition. Joints for bronze welding must be vee'd when the thickness is over 1/8 in.; for brazing, vee'ing is undesirable.

Brazing is easily adapted for automatic or semi-automatic operating. However, both processes rely on the adhesive power of the jointing metal, both use copper-zinc alloys as bonding materials, and both may be used to join similar or dissimilar alloys. The author believes the name "bronze welding" is misleading and should be replaced by a term such as "weld-brazing" or "brazwelding."

—E. Christie, *Sheet Metal Inds.*, Vol. 16, Aug. 1942, pp. 1199-1205.

Drop Hammer Techniques

Condensed from "Aviation"

Drop hammer technique in aircraft differs considerably from that in other fields because there is no choice but to use a very light, exceedingly high tensile material. With simple pieces, the sheet is first lightly pressed down into the die with a light blow of the hammer. The punch is then raised and any wrinkles removed with a hand hammer.

If the wrinkles are not removed, they will fold over and form a lap in the finished articles. The forming is then completed with a few solid blows of the hammer. The face of the die should be frequently wiped with oil to facilitate forming. Wrinkling is most likely to occur at the beginning of the operation. The tendency to wrinkle is exactly proportional to the depth of the draw and the ability of the operator to control them. They tend to develop particularly in the area where shrinking begins.

The Three Methods Used

There are three different methods of forming articles which are prone to wrinkle. First is the use of pressure rings of plywood or rubber (3/16 to 1/2 in. thick) which are piled on the sheet metal, after it is placed in position on the die, to a height of slightly less than the contemplated draw. The usual practice is to place a steel ring of the same shape as the other pressure rings on the bottom directly over the metal sheet. After each blow of the hammer, at least one and preferably more pressure rings should be removed until the part is formed. The deepest draw that can be made in each instance must be determined by experimentation.

Wrinkling can also be eliminated by using successive dies, each one bringing the projected part closer to its desired shape. The cost is not exhorbitant since the first dies are merely for roughing operations and only the last die must be made to accurate tolerances. It is possible to cast the progressive dies together so that more than one die can be used on a hammer at the same time.

The third method utilizes the ability of rubber to flow like a fluid. Pneumatic hammers are preferable for this type of work. If certain bends must be formed first in compound shapes to prevent tearing, a piece of rubber placed on the sheet where trouble is expected will localize the blow so that the sheet below the rubber

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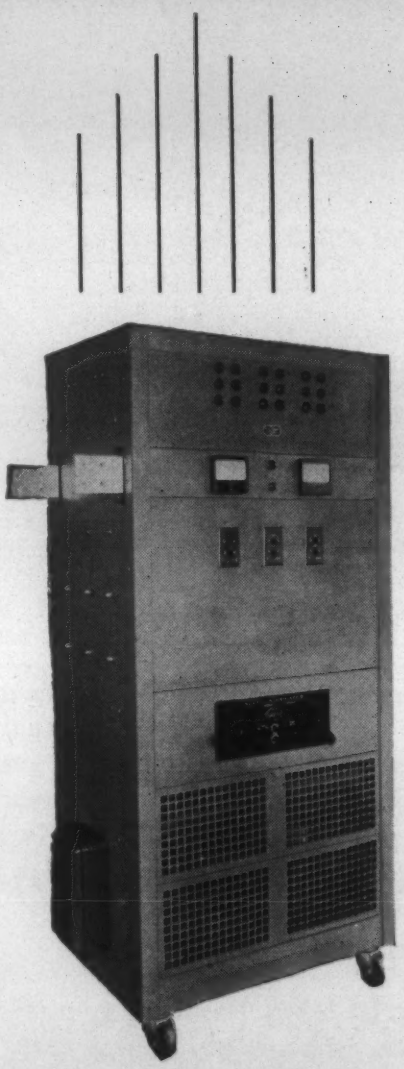

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is formed before the rest of the sheet. The rubber is then removed and the part finished in the regular manner.

Grooves (or Deep Draws)

In the case of deep draws, grooves are sometimes cut into the die and mated by the punch; these grooves act to restrain the sheet as would pressure rings. Where the construction of the die will not permit the cutting of such a groove, pieces of rubber around the ends of the sheet where the falling punch will contact them serve the same purpose.

This practice is not generally recommended as it is crude compared to other methods. In deep draws, wrinkles can sometimes be prevented by laying slabs of rubber (¾ to 1 in. thick) on the part being formed, thereby restricting the depth of draw from each stroke of the hammer. One or more layers of rubber is removed after each blow.

The average drop hammered part is shrunk around the outside edge. If a part must be shrunk in the center, a pyramid of different size sheets of rubber (½ in. thick) is placed on the sheet. As the punch strikes the small piece of rubber on top of the pyramid, the blow is most intense here. Thus wrinkles are prevented from developing in the center of the sheet. It is the general custom to return to the hammer drop hammered parts that have been heat treated for final straightening by a few blows.

—C. J. Frey and S. S. Kogut, *Aviation*, Oct. 1942, pages 130-133; 285.

Die Casting Inserts

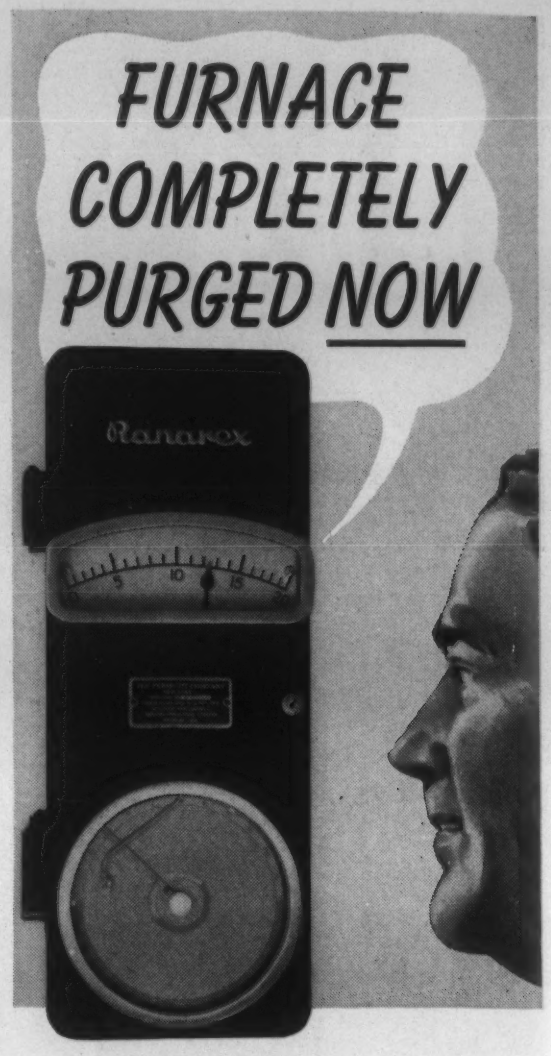
Condensed from "American Machinist"

Die castings do not have the strength of many wrought metals; they lack magnetic properties, as well as friction and bearing characteristics of some other metallic materials, and do not lend themselves to welding to steel. But all these properties are readily gained by the simple use of inserts cast in place. Similar benefits may sometimes be gained by applying the insert after casting, but economy in so doing is likely to be sacrificed.

Examples are given, including use of steel inserts for teeth of machine part of zinc alloy to increase wear resistance; insert of bronze half sleeve to give better bearing surface; insert of tempered steel form inserts in zinc alloy, (casting temperature of zinc is too low to decrease hardness of tempered steel); inserts of magnet steel pole pieces and brass bearing sleeve in magneto housing of aluminum; perforated steel plate insert to increase bending and shearing strength of zinc alloy pipe cutter frame; plastic insert for constitute dielectric in zinc casting; pressed paper insert in zinc pulley to form friction surface with which the belt contacts; and hardened steel blades and central bushing inserts in zinc die cast body to make up a valve seating tool.

Producers of die castings are not always enthusiastic about inserts because they slow casting cycles, but they are usually quite willing to apply inserts if given adequate compensation for extra operating cost.

—H. Chase, *Am. Machinist*, Vol. 86, Sept. 17, 1942, pages 1010-1011.



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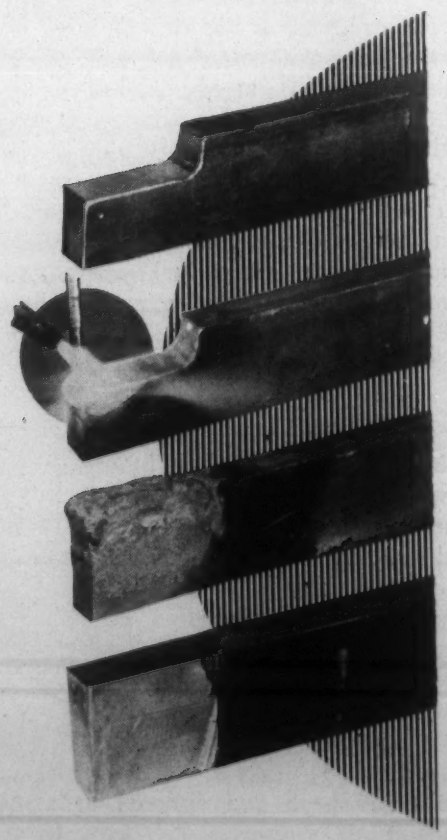

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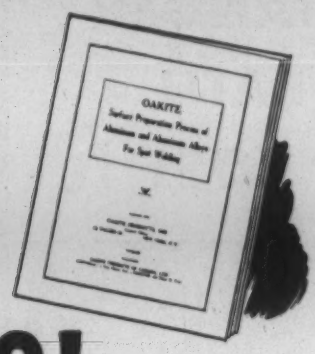

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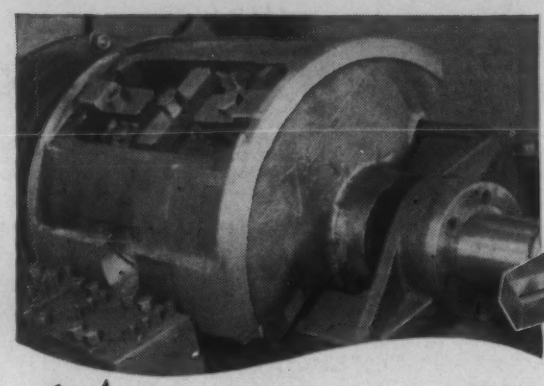

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Contacts from Metal Powders

Condensed from "Engineer"

Pure metals are not satisfactory contact materials. Silver and copper meet conductivity requirements but are only used where other requirements are not too important. Tungsten and molybdenum are used where requirements overbalance the conductivity needs. An ideal material for most contact purposes would be one which has hardness, density and the electrical and heat conductivity of silver and the low material transfer of tungsten. Powdered metal compounds are satisfactory for contact purposes. Methods of producing such materials are:

Three Methods Used

Method No. 1: The starting material is a powdered metal such as tungsten or molybdenum. It is pressed into the desired shape and sintered. It is then in the form of a sponge and the pores are filled by capillary attraction with melted silver or copper.

In Method No. II a mixture of two powdered metals such as tungsten and silver are pressed and pre-sintered at low temperature. Material is then machined into final shape and sintered at a high temperature.

In Method No. III the material is the same as in No. II, except that the raw material may be processed differently, pressure varying with the type of the material used — about 40-80 tons per sq. in. After pressing, the material is sintered, the temperature varying with the basic material and its final application. Forming is done either hot or cold.

The chief things to know in producing these materials are: (1) What microstructure is needed for certain characteristics; and (2) How to influence the microstructure to obtain the desired characteristics. The type of powder used in the tungsten and molybdenum group has a great effect on the microstructure and characteristics of the final product.

In a compound of 60 per cent Mo and 40 per cent Ag the molybdenum particles show slight preferred orientation in a plane perpendicular to the axis of applied pressure. Distribution in this compound is uniform. For air circuit breakers oxidation is detrimental, and a silver-tungsten compound is preferred. It consists of 90 per cent W and 10 per cent Ag. For contact purposes the density must be as near as possible to theoretical.

Factors Affecting Density

Density depends largely on heat treatment. By sintering for a sufficiently long time, it is possible to obtain a density within 99 per cent of theoretical. To arrive at a definite density from a 2 or 3 component powder, watch must be kept on composition, initial pressure, temperature, mechanical treatment, and subsequent heat treatments.

The hardness of the compound is influenced in the same way as density. A material with 82 per cent W and 18 per cent Cu was made with different types of copper. Density did not vary much, about ½ to 1 per cent; electrical conductivity not more than 7 per cent, but change in hardness varied 16 to 20 per cent, depending only upon the type of copper powder. The tensile strength is not as important as other characteristics but it cannot be completely ignored. The most important properties are thermal and electrical conductivities. These are a function of electron properties of the metal.

Besides the properties discussed, a good contact material should not weld or stick, should have permanency of shape and ease of brazing. Arcing contacts need a high density and have to be very hard. Conductivity is of secondary importance. Main contacts, however, require high conductivity.

—*Engineer*, Vol. 174, Aug. 21, 1942, pages 146-149.

Electrolytic Tinning

Condensed from "Monthly Review," Am. Electroplaters' Soc.

Among the advantages of electro-tinning over hot dipping are: (1) The thickness of the coating can be accurately controlled. (2) Very heavy deposits can be made if necessary, whereas hot-dipping can give only about 0.001 in. (3) The high throwing power of the stannate bath makes it possible to obtain uniform coatings on objects of very irregular shapes.

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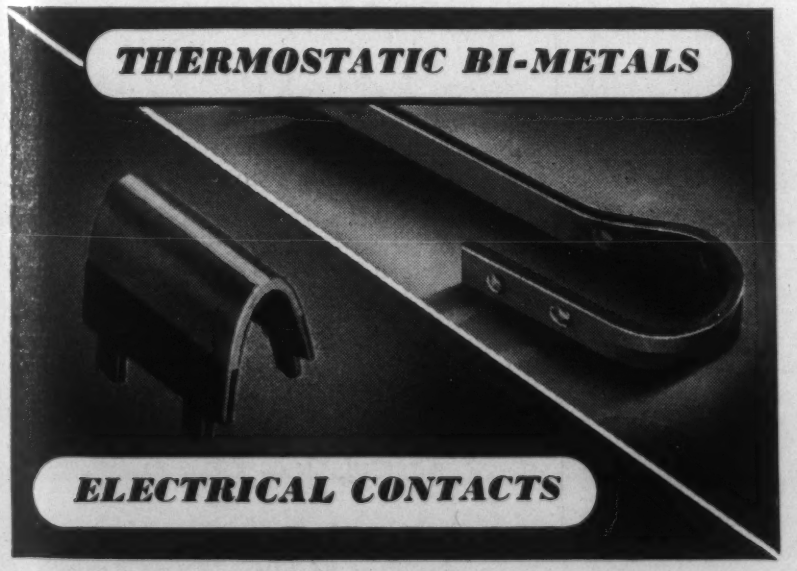

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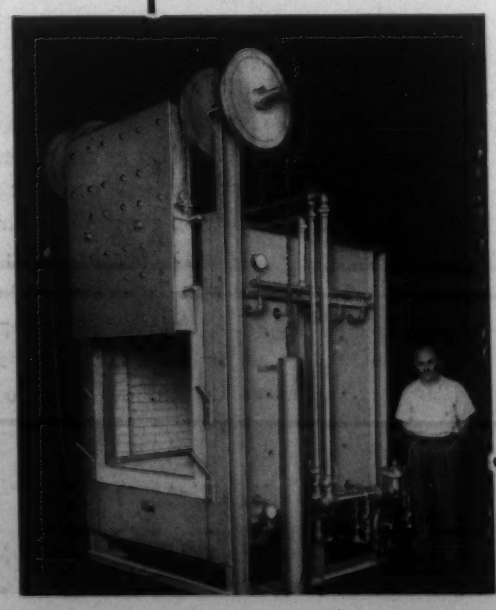

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Tin coatings are too soft to finish satisfactorily with the usual buffing operations. Wet scratch-brushing with a soft brass or nickel silver wire brush gives an attractive finish without loss of tin. Soluble oil, lanoline emulsion, or size may be added to the water for scratch-brushing. Steel tanks with a loose glass lining are preferable. A normal range of bath composition is:

	Oz. per gal.
Sodium stannate, $Na_2SnO_3.3H_2O$	9 to 16
Free caustic soda	1.5 to 2.5
Sodium acetate	2.5 to 2
An initial addition of hydrogen peroxide or sodium perborate	0.06

Sodium acetate is not essential but its use widens the range of suitable operating conditions. Hydrogen peroxide and sodium perborate are oxidizing agents which oxidize any stannite to stannate. Current densities of 10 to 25 amp. per sq. ft. are used, with 15 amp. per sq. ft. a normal value. Anodes are of pure tin. The anode area should be about 1⅓ times the cathode area. The anode efficiency is 75 to 95 per cent.

It is very important that conditions are such that the tin dissolves in the stannate form. When this is the case the anodes are covered with a greenish-yellow coating. If the anodes are gray or coated with a thin loosely adherent film of dark particles, the anode current density is too low and the tin will dissolve in the stannite form and tough spongy deposits will be produced.

If the current density is too high, the anodes become covered with a black oxide film and become passive. If the anodes are kept in the tank they must be bolted or clamped to the busbars and not merely hung by hooks.

On commencing to plate, a current density of 1.5 to 2 times the normal value is applied for about 1 min. The yellow film will form and when formed the voltage will rise about 2 volts and the current will fall correspondingly. After the film has formed the current density should be reduced to the normal value.

The critical current density range in which the anodes dissolve in the stannate form varies with the free caustic soda content, temperature, and stannate concentration. A table relating these variables is given.

The concentration of free caustic soda should be checked twice weekly. If it is too low, insoluble tin hydroxide will form. Over a period of several months, excessive quantities of sodium carbonate form in the bath and result in lowered cathode efficiency. Sodium carbonate can be removed by immersing a tray of iron or nickel gauze in the bath and cooling. Crystals of sodium carbonate form on the gauze and can be easily removed.

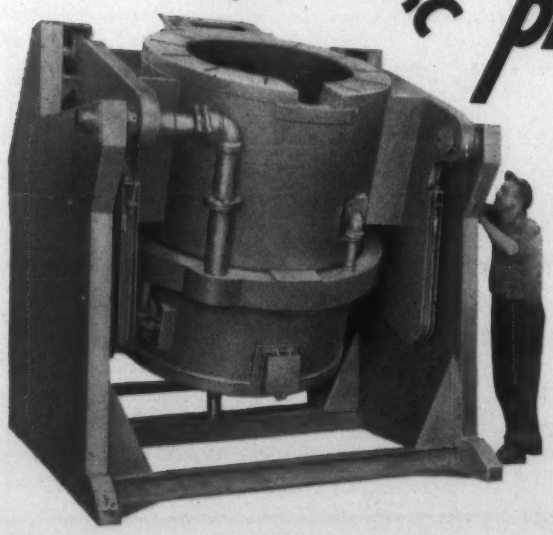
The most suitable concentration of stannate and free caustic soda vary with temperature and current density. A chart is given showing these relationships.

To improve the color of the deposit addition agents such as lactic acid (6 gm. per liter), tin resinate (¼ gm. per liter) or resin (¼ gm. per liter) are sometimes added. They must be used with caution. Raising the temperature or lowering the current density will often improve a dark or rough deposit. If not, stannite ions may be present and must be oxidized by addition of hydrogen peroxide or sodium perborate. Metallic impurities may cause trouble, but usually disappear with working.

Complete directions are given for analytical control of the bath.

—S. Baier, *Monthly Rev.*, Am. Electroplaters' Soc., Vol. 29, Sept. 1942, pages 735-749.

Section of assembly floor in Fisher's new plant producing MNP Furnaces.



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Fisher FURNACE COMPANY

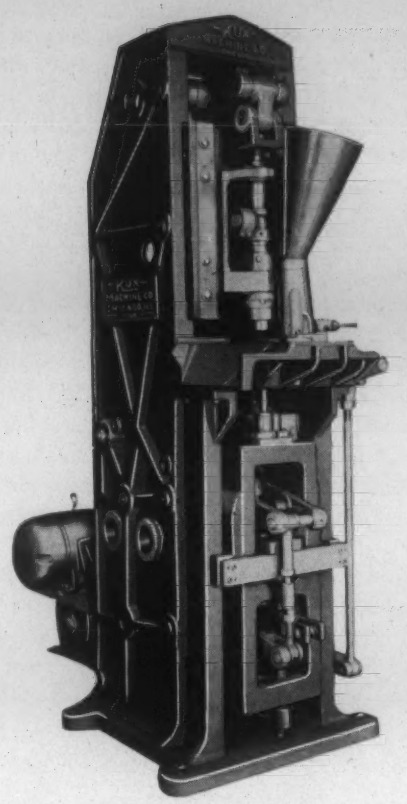
Spot Welding Alloy Steels

Condensed from an American Welding Society Paper

The object of this investigation was to determine how to produce tough, ductile spot welds in 0.040 in. thickness S.A.E. X-4130 steel, a steel that when spot welded by conventional methods produces an extremely brittle weld with low mechanical properties.

In commercial heat-treating practice it is well known that hardenable steels, after being drastically quenched to martensite, can be toughened by drawing to a temperature just below the critical. This drawing allows the precipitation of carbides held in super-saturated solution in the martensite, thus producing a tough, ductile transformation product by softening of the matrix.

A recent investigation by W. F. Hess



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and C. R. Schroder on "N-A-X 9115" high-tensile steel showed that the brittle "as welded" structure in this steel should be tempered by a brief post-heat in the welding machine after allowing the weld nugget to cool just to the martensite-forming temperature. Longer time off than that necessary to reach the martensite-forming temperature was held to be undesirable, due to the possibility of cracking of the martensite if allowed to cool to room temperature.

[According to another A.W.S. paper (by Schroder) at the 1942 convention, with N-A-X steel, the weld, cooling cycle and heat-treating cycle are all made with one contact of the electrodes and one sitting of the electronic control equipment. The time required to make a complete weld of this type in 0.040 in. material is less than 0.5 sec. The time required to make this weld in 0.070 in. material is about 0.75 sec. The slightly increased total time required, as compared with older methods, is certainly practical in view of the greatly increased weld ductility and resistance to normal stress.]

Control of Operating Variables

By means of operating two standard spot welding panels in conjunction with each other, but with separate phase controls, the following variables were accurately controlled: (1) Welding current, (2) welding time, (3) time between termination of welding current and start of heat-treating current, (4) heat treatment current, and (5) heat treatment time.

The results obtained with N-A-X 9115 by this method were so successful that it was felt worth while to extend this technique to other steels of greater hardenability.

Optimum Conditions

Surveys of the effects of the factors previously mentioned showed the following values to be best:

Flat electrode diameter, in.	¼
Electrode shape	30 deg. bevel
Unit electrode pressure, lbs. per sq. in.	30,000
Corresponding total electrode force, lbs.	1473
Weld time, cycles	6
Weld current, amps.	12,800-13,200
Time between weld and heat treatment, cycles	18
Time of heat treatment, cycles	6
Heat treatment current, amps.	11,400-11,800 (88-92% of weld current)

The results of this investigation have shown that it is possible, by means of a brief post heat tempering in the welding machine, to produce tough, ductile spot welds in the hardenable steel S.A.E. X-4130, 0.040 in. thickness. By use of the welding conditions just mentioned, the shear strength was raised from 1130 lbs. in the "as welded" condition to 2610 lbs. when heat treated. At the same time the tensile strength increased from 160 lbs. to 830 lbs.

Work now being conducted on other medium-carbon S.A.E. steels indicates that this technique is generally applicable to a great many hardenable steels not commercially spot welded at present.

—W. F. Hess & D. C. Herrschaft, *Paper, Amer. Welding Soc.*, Oct. 1942 meeting.

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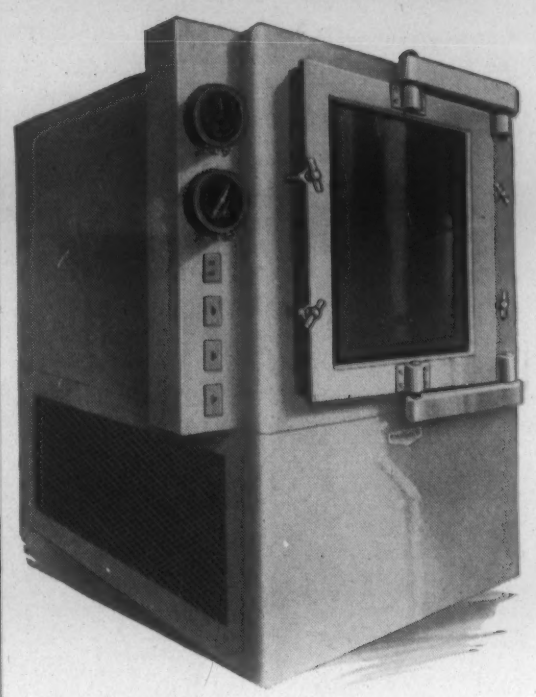

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Heat Treatment of Tool Steels

A Composite

Considerable information of practical value to those concerned with the heat treatment of tool steels of all types was contained in a group of 3 papers presented at a "tool steels" session during the American Society for Metals' recent convention in Cleveland. All based on S-curve data, they demonstrate the importance of cooling to a sufficiently low temperature in the quench before tempering and provide some new ideas about hot-quenching—although the authors are evidently not in agreement on the mechanisms by which the final results are obtained.

How to Quench 11 Tool Steels

As a practical help to heat treaters, the "S" curves of 11 commercial tool steels (1.1% C extra tool; 1% C - 1.2% Cr, tungsten fast-finishing; manganese oil-hardening non-deforming; 0.3% C - 5% Cr - 1.2% W - 1.5% Mo hot-work; 1% C - 5% Cr air-hardening; 1.5% C; high-carbon high-chromium air-hardening; 18-4-1 high speed steel; 18-4-1 with 5% Co; 5-4-4-1; and 5-4-4-1 with 5% Co) have been investigated with particular reference to the martensite portion below Ar" (P. Payson & J. L. Klein, "The Hardening of Tool Steels," American Society for Metals, Preprint 29, Oct., 1942 meeting.)

Emphasis is placed on the fact that the formation of martensite from austenite does not take place at a constant temperature as indicated in the early "S" curves, but is a reaction depending for its completion only on a decrease in temperature. Martensite begins to form immediately as soon as a certain temperature (which varies with the composition of the austenite) is reached.

Furthermore, if austenite is cooled to a temperature below Ar" and held for a long time, some of the austenite will transform immediately to martensite and the balance may eventually transform to bainite. The austenites of these tool steels are not transformed completely (or nearly so) until cooled *almost to room temperature*, and, in the case of some of the more highly-alloyed steels, 5-10% austenite may be untransformed even at room temperature.

If the tool is put in the tempering furnace before the austenite has been permitted to transform completely (while the tool or die is perhaps at 200 deg. F.) and if the tempering is carried out at a temperature where the austenite transformation is slow (for example, 300 deg. F. for carbon tool steel), the supposedly "tempered" tool will actually contain some untempered martensite formed on cooling from the tempering temperature. Obviously, such untempered martensite is brittle and may lead to cracking and premature service failure.

Two practical rules for heat treaters, therefore, are: (1) Cool the tool or die almost to room temperature before tempering; (2) if the tool or die is likely to crack when permitted to go cold in the quench, a double temper is the best solution, but the steel must be cooled to room temperature after the first temper.

Various examples are given of the effect of austenitizing temperature on subsequent martensite formation. Grain size, *per se*, apparently has no effect on the martensite formation, but changes in composition of the austenite due to solution of carbides markedly affect the martensite formation.

As the austenitizing temperature is increased, more carbides go into solution with a resultant retardation of the martensite formation. After all carbides are in solution, additional increases in austenitizing temperature do not change the martensite formation.

Heat Treating High Speed Steels

Quantitative "S" curves for 18-4-1 and 6-6-2 high speed steels have been obtained to supersede previous qualitative curves (P. Gordon, M. Cohen, & R. S. Rose, "The Kinetics of Austenite Decomposition in High Speed Steel," *Ibid.*, Preprint 30). A quantitative metallographic technique was used to convert dilatometric measurements to per cent transformation on an absolute basis.

The curves for both steels are very similar. There are 2 ranges of isothermal activity: 1400-1200 deg. F. and 675-350 deg. F. In the upper range, the product of isothermal transformation is very fine pearlite, preceded or accompanied by carbide precipitation, and in the lower range, acicular bainite. The pearlite transformation always goes to completion if the holding time is long enough but the bainite transformation stops long before the

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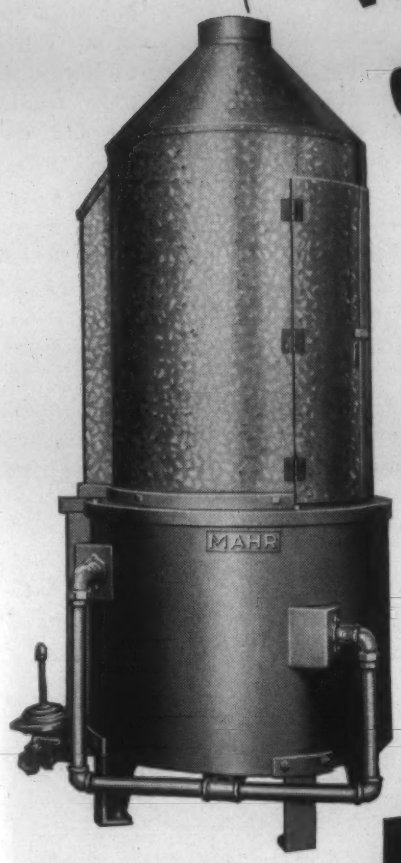

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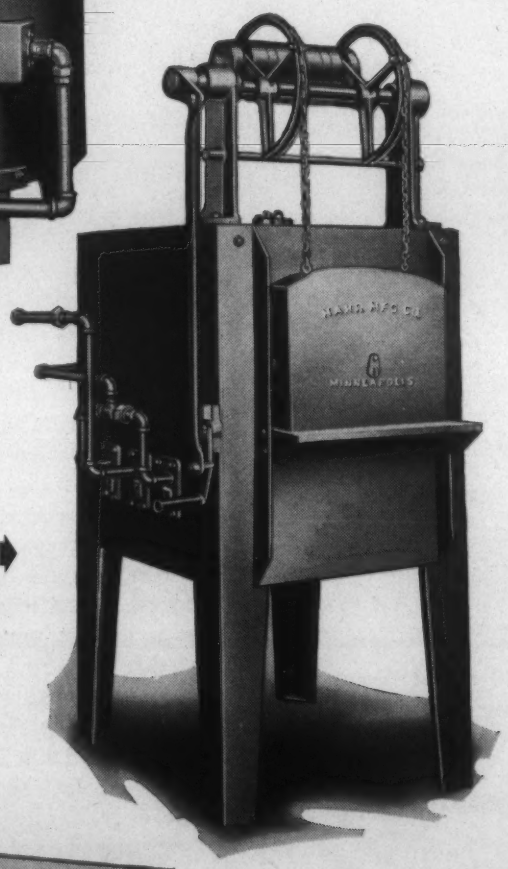
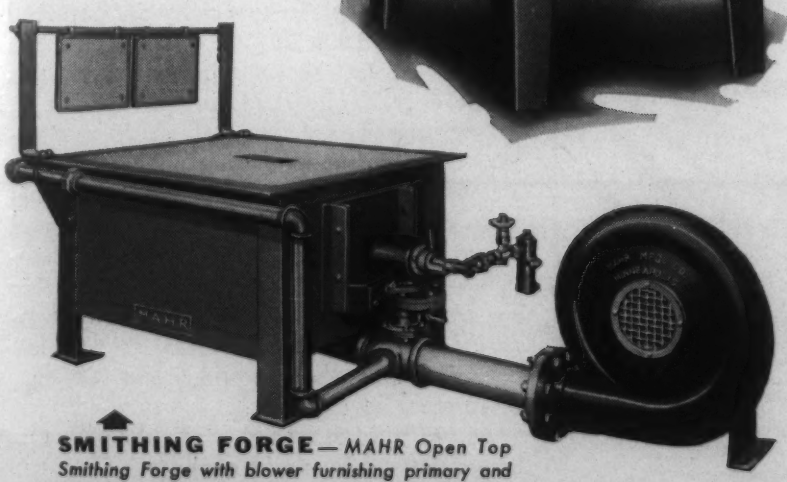


TOOL FURNACE—*MAHR Standard Tool Furnace. Under fired to 1800° F. for regular tool steels. Over and under fired to 2600° F. for high speed tool steels.*



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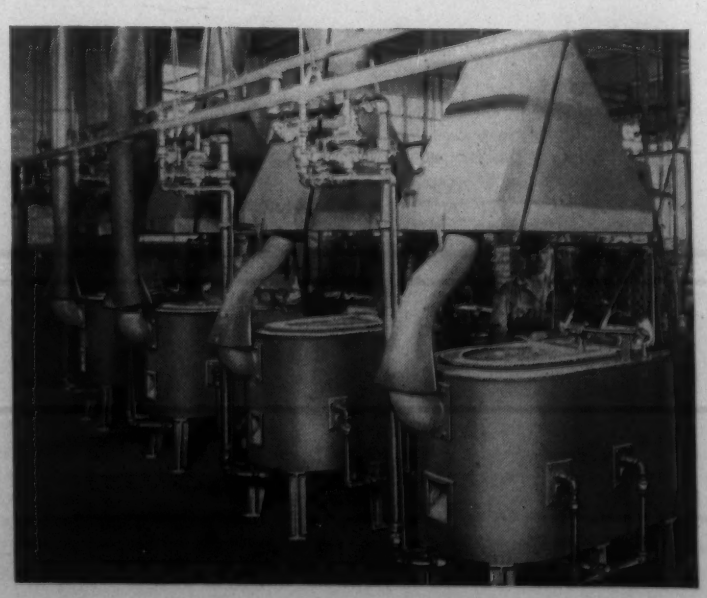

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austenite is exhausted.

On cooling (6-6-2 from 2235 deg F. and 18-4-1 from 2350 deg. F.), the martensite transformation starts at 420 deg. F. for the 6-6-2 and at 430 deg. F. for the 18-4-1. There is no observable incubation period prior to the martensite formation.

Hot quenching below the martensite point leads to martensite formation during cooling from the martensite point to the holding temperature, followed by isothermal bainite formation—which takes place in 2 stages: First occasional plates of bainite in the martensite, then general formation of bainite. The more bainite that is formed isothermally above the martensite point, the lower is the martensite point of the remaining austenite.

No observable isothermal transformation takes place on hot quenching for 24 hrs. at 700-1100 deg. F. But hot quenching, especially over 900 deg. F., conditions the austenite for bainite formation at the expense of martensite during subsequent cooling. If the holding time and temperature are increased, the amount of bainite formed is also increased, leaving less austenite available for martensite formation. Rapid cooling, however, tends to suppress the bainite formation, reserving more austenite for decomposition into martensite. Many combinations of pearlite, bainite, martensite, and retained austenite may be secured by suitable hot quenching treatments.

Commercial hot quenching may be viewed in the light of these transformation curves. The possible occurrence of pearlite and carbide precipitation during hot quenching, especially of large tools, has not been fully appreciated and might lead to inferior properties. Hot quenching at 1000-1100 deg. F. may introduce unexpected effects because the steel is thereby conditioned for bainite formation at the expense of martensite.

Tempering of Carbon-Chrome Steels

A different aspect of austenite decomposition has been studied in an investigation of the kinetics and mechanism of the structural changes accompanying the tempering of 1% C-5% Cr and 1.5% C-12% Cr tool steels (O. Zmeskal & M. Cohen, "The Tempering of Two High Carbon High Chromium Steels," *Ibid.*, Preprint 31).

These steels retain unusually large percentages of austenite at room temperature, even when relatively slowly cooled (1% C-5% Cr cooled from 1800 deg. F. retains about 29% austenite for oil quench, 35% for air cool, and 40% for lime cool, while equivalent figures for 1.5% C-12% Cr are 19%, 25%, 29%).

For a given hardening treatment, more austenite is retained by the 1% C-5% Cr steel but it is less stable than that retained by 1.5% C-12% Cr. This indicates that carbon is more potent than chromium in lowering the martensite range on quenching, but that chromium is more potent in retarding the decomposition of the retained austenite. The higher the heating temperature, the greater the amount of retained austenite and the greater its stability.

Retained-austenite transformation curves are somewhat analogous to "S" curves, but the former show percent decomposition of retained austenite after tempering and cooling to room temperature. The retained austenite of 1% C-5% Cr steel undergoes rapid isothermal transformation to bainite at 500-600 deg. F. especially if quenched from below 1800 deg. F., while the 1.5% C-12% Cr steel shows some activity in this range only if quenched from 1700 deg. F.

Both steels are very sluggish at 700-800 deg. F., but tempering above 900 deg. F. conditions the austenite for transformation during subsequent cooling. At and above 1100 deg. F., the austenite decomposes isothermally, leaving less available for transformation on cooling. After tempering, transformation occurs at 650-450 deg. F. forming bainite and below 300 deg. F. forming martensite.

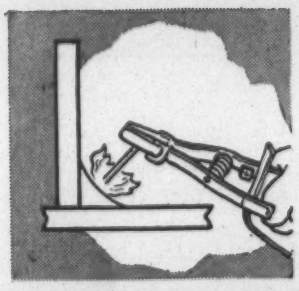
As with high speed steel, bainite can be suppressed by rapid cooling. Also, the higher the tempering temperature and time, the more the formation of bainite is promoted at the expense of martensite.

There is no apparent effect of quenching rate from the austenitizing temperature on the stability of retained austenite. When a given tempering temperature is insufficient to decompose all the retained austenite, successive increments of austenite can be transformed by multiple tempering.

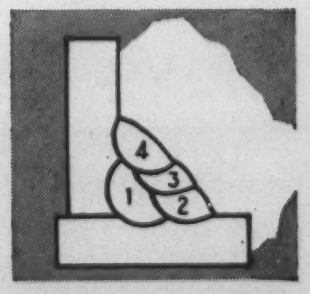
X-ray studies showed that the as-quenched steel contains tetragonal martensite which is changed to cubic on tempering at 200-500 deg. F. There is some evi-

HOW TO SAVE UP TO 40% OF WELD METAL IN FILLET WELDING

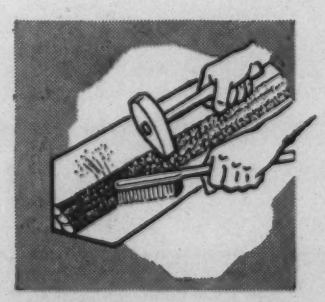
Murex engineers have long advocated the welding technique illustrated here, in order to reduce the amount of electrodes used on fillet welds. Savings up to 40% of weld metal can be achieved with this method. In addition, stronger welds are produced and production is speeded. Because of the serious electrode shortage, adherence to this technique makes an important contribution to our conservation program.



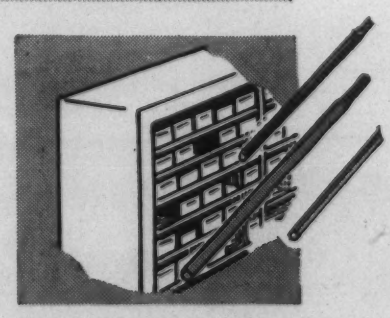
Holding the electrode at the proper angle will give the most effective deposit of weld metal. In downhand work, the electrode should be held at an angle of 45° to 50° to the horizontal plate and about 20° off the vertical, leaning in the direction of the welding.



Where multiple passes are used in fillet work, the beads should be laid from the bottom upward in the sequence, as shown. Valleys may be avoided by using an intermittent weaving motion, occasionally flicking the arc to feather edge the metal being deposited into the previous bead.



Cleaning time can be saved by leaving on the slag until each layer of beads has been completed instead of cleaning each separate bead.



Select a type of rod, of the largest size practical, that will permit the use of high currents, taking into consideration thickness of plate, amount of penetration and soundness of deposit required.

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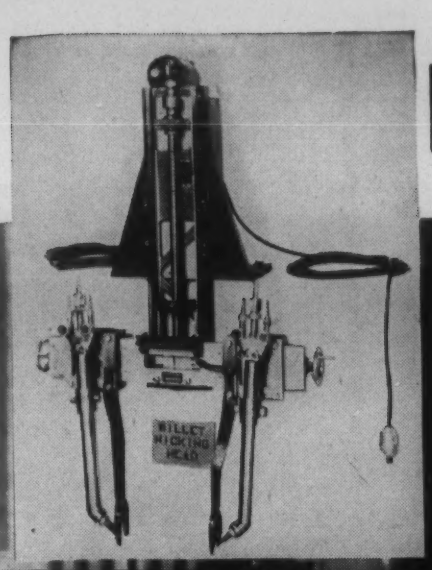

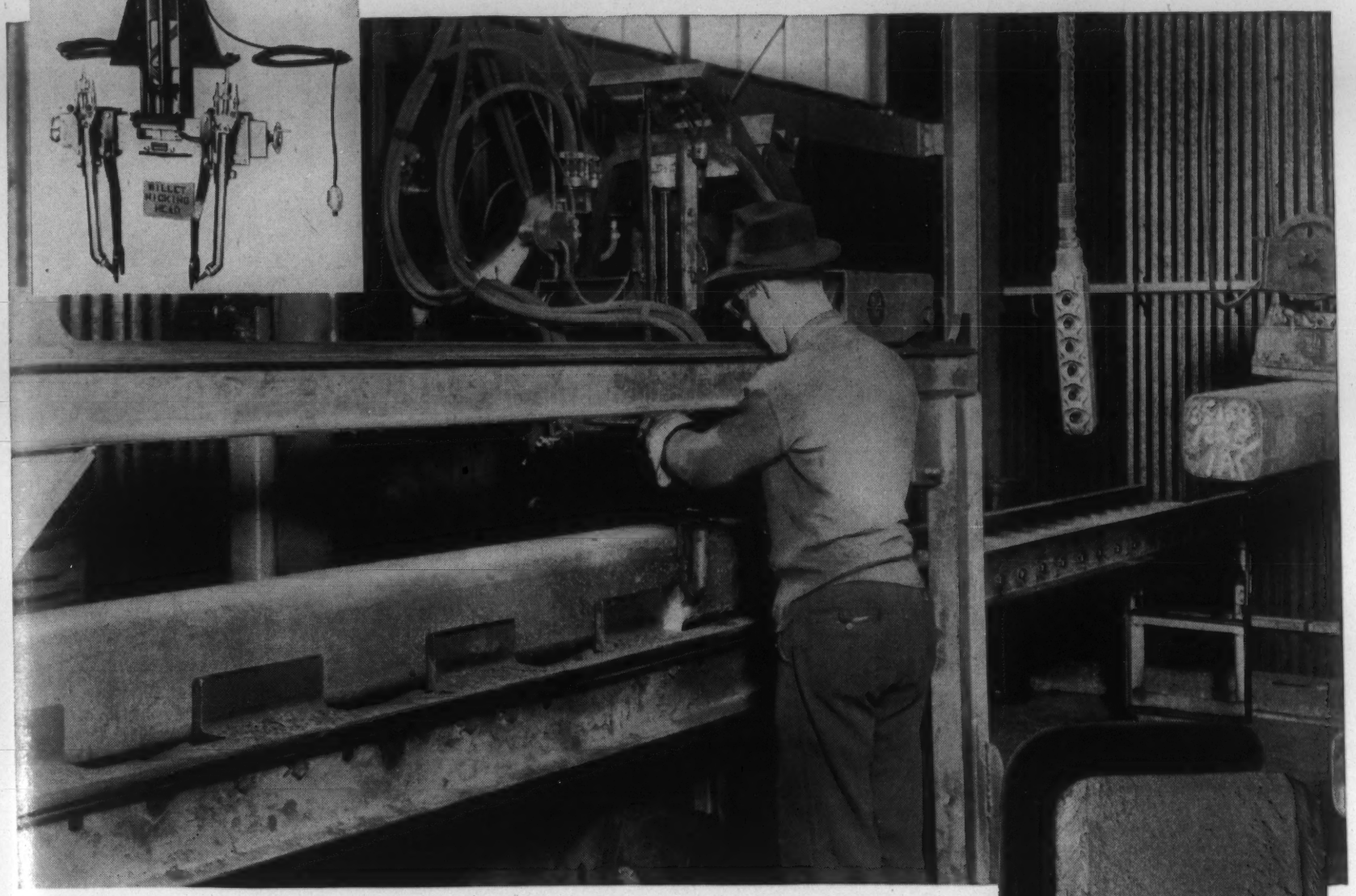

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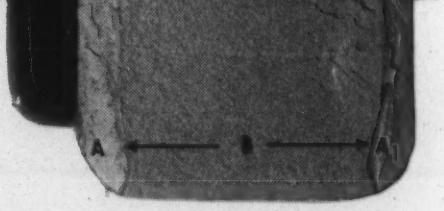
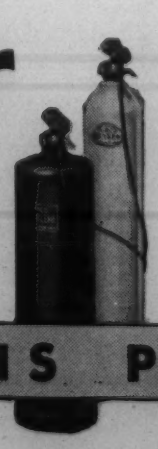


A and A_1 show areas of gas nick. B is section broken by hammer blow, after nicking.

Air Reduction



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dence of a carbide precipitation from the tempered martensite at 450-600 deg. F. (Included in the discussion of this paper were "S"-curves for both steels as well as hardness values after various tempering treatments.)

Welding Aero Propeller Blades

Condensed from an American Welding Society Paper

Airplane engine power can be utilized only as far as it can be matched by propeller performance. The development of larger and faster planes, therefore, may be said to hinge largely on corresponding propeller developments.

Solid propeller blades are built from wood and aluminum, hollow blades only from steel. In spite of higher cost and more complicated manufacture, hollow steel blades have defended their position for the following reasons: (1) Lighter weight because of the superior static mechanical properties and endurance strength of steel, and (2) greater hardness and abrasion resistance.

Four different methods of manufacturing hollow steel blades are noted among the main blade producers. At present the Curtiss Propeller Division is the largest manufacturer by a wide margin, and also has built the largest steel blades for a 3-blade propeller whose nominal HP rating is 2600 and diameter 16 ft. 6 in.

Construction of the Curtiss Blade

The Curtiss hollow steel blade is the only one on the market assembled entirely by welding. The component parts are the camber or curved plate which rolled up in one end to form the shank, and the thrust or flat plate. Both plates are milled, blanked, and formed and then assembled in the welding jig.

The thrust plate is joined to the camber plate entirely through atomic hydrogen welding. The shank seam and cuff retaining ring are welded by the Unionmelt process. The shank seam and the small part of the blade where the edges are formed through the folding over of the camber plate in addition are welded on the inside with an oxyacetylene torch. The purpose is to eliminate cold shuts which may arise at the root of the atomic weld in the heavy sections and to obtain a smooth interior weld surface.

The rest of the blade edges are filleted with copper to eliminate stress concentrations due to eventual lack of smoothness on the inside of the edges. Following brazing the structure of the steel is rendered uniform and fine-grained through normalizing. The blade subsequently is heated above the critical and is straightened hot and quenched through a single die operation. It is finally drawn to a hardness of Rockwell C 26 to 32, and a minimum tensile strength of 135,000 lbs. per sq. in.

The blade finally proceeds through a number of mechanical and inspection operations. After completion of welding it passes through a total of 38 inspection operations including 4 X-ray and 6 Magnaflux inspections. One inspector is required for every 5 operators.

The most recent improvements incorporated in the Curtiss blade are copper filleting, wet Magnaflux inspection, thickened blade edges, X-ray inspection and Unionmelt welding of the shank seam and cuff retaining rings.

Some "Materials" Considerations

Though the atomic hydrogen welding method is sensitive to steel quality, it is an excellent tool for blade welding because of its cleanliness. It has been found more rapid than arc welding. The total welding time per blade is 6-man hrs., three of which are allotted to relaxation and fatigue.

To reduce steel rejections because of poor atomic-hydrogen weldability, Curtiss Wright has contracted with the Battelle Memorial Institute for an investigation of the factors affecting weldability. The research conducted by Battelle has indicated sulphur plays a dominant part, but it is not the only factor, and others are now being investigated.

Material specifications for propeller blade steel are governed by physical properties to a greater degree than by chemical analysis. Heats showing comparatively wide deviations in chemical analysis usually are accepted when the physical requirements are met. Speedy and accurate spectrochemical methods are used in the analysis of propeller blade steel.

—C. A. Liedholm, Paper, *Amer. Welding Soc.*, Oct. 1942 meeting.

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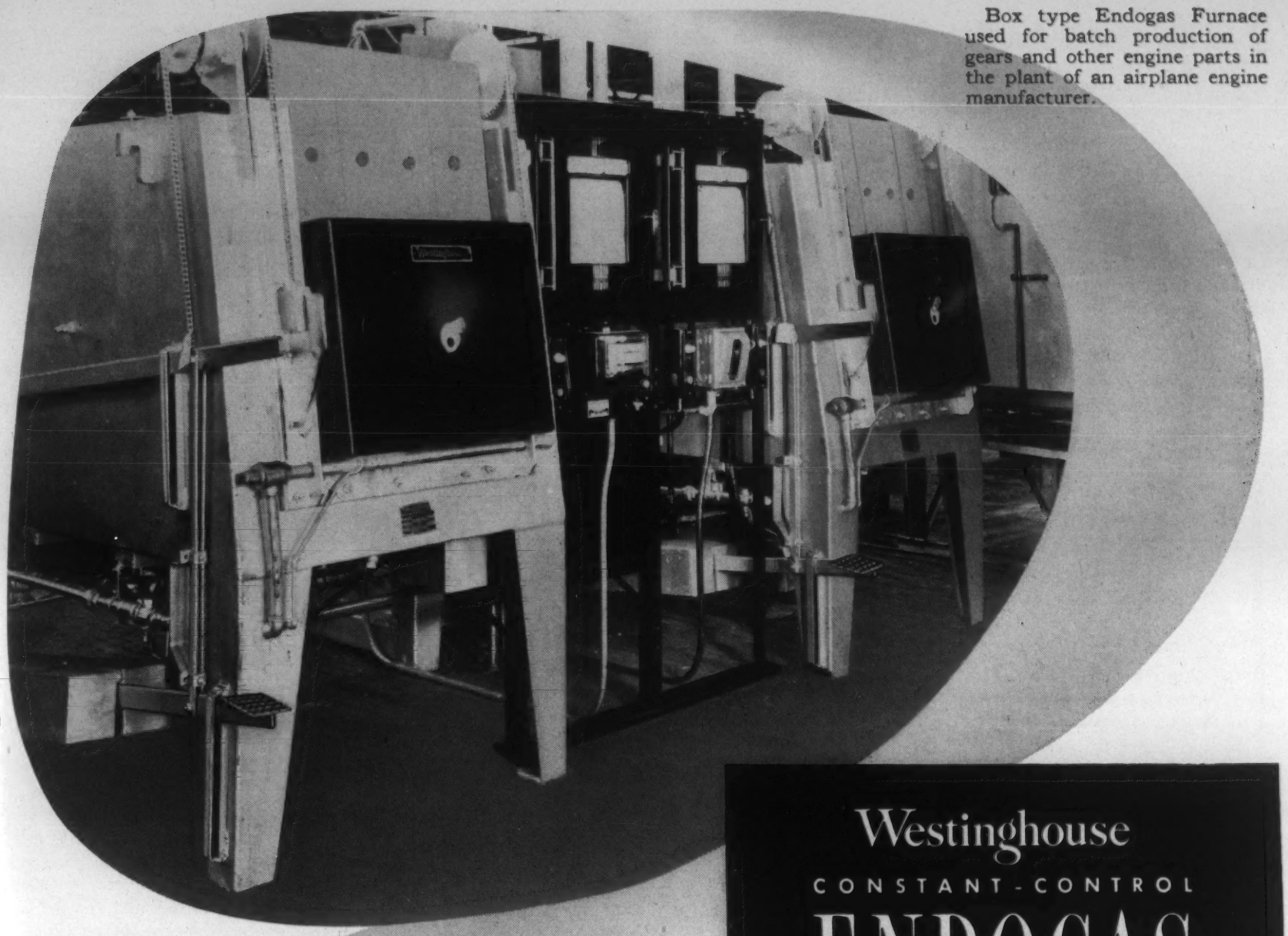

Box type Endogas Furnace used for batch production of gears and other engine parts in the plant of an airplane engine manufacturer.

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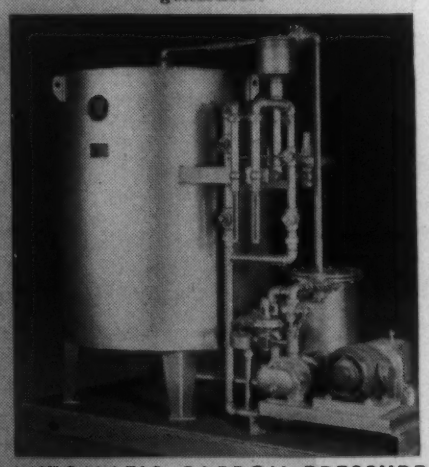

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Westinghouse ENDOGAS—the *constant-control* heat-treating atmosphere greatly simplifies continuous production in hardening applications.

ENDOGAS permits clean-hardening of any SAE steel without decarburization. It is derived directly from ordinary fuel gas. It consumes no charcoal, coke or other solid or liquid fuel which must be replaced. Westinghouse has developed *automatic carbon pressure control* which maintains a constant "carbon balance" with the steel to be treated. This enables clean-hardening any SAE steel parts on a continuous production basis without decarburization or carburization.

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J-10235

COMPLETE HEAT-TREATING EQUIPMENT

Distortion in Ship-Welding

Condensed from an American Welding Society Paper

Shipbuilders and construction forces have done much to improve control of welding to reduce distortion and to devise methods for correcting distortion; but wide variation in methods employed and in the effectiveness of these methods, as observed in a broad survey of many shipyards and fabrication plants, indicates the need for more engineering control and for practical research to provide a better basis for this control. The factors involved are so complex that the effects of many of them cannot be studied and evaluated accurately in regular production work.

Distortion is objectionable mostly because of appearance, but it can lead to technical difficulties resulting from eccentricities and to practical difficulties encountered in subsequent work. One of the most important considerations that calls for better control of welding, gas cutting and heating operations, is the need for conserving strategic materials such as welding electrodes and oxygen.

Weld shrinkage, the cause of the major part of the distortion commonly experienced, is often blamed for distortion resulting from other causes such as rolling mill stresses, rough handling and improper storage of materials, poor fit-up and fabrication errors, buckling under gravity loads or other external forces, changes of atmospheric temperature, over shrinking in flame straightening, and improper design and details.

Essential Precautions

The most important general precautions to be taken during construction against welding distortion are:

(1) Avoid over size welds and more welding than is required.

(2) Provide proper support for welded assemblies and devices to hold them straight or fair during welding, so that the shrinkage will largely be absorbed in the hot plastic metal.

(3) Distribute the heat of welding so that expansion or contraction will not be built up locally to so much higher a degree than in other parts of the assembly, that the inherent stiffness of the assembly is not sufficient to resist the distortion forces.

(4) Use the size and type of electrodes, welding current, welding speed and other details of welding procedure that will result in least distortion for the thickness of material and local stiffness of the assembly involved.

The designer and detailer can do a great deal to facilitate distortion control by holding down the amount of specified welding to minimum requirements based upon strength, stability and soundness of welds. Continuous welding usually involves a greater total amount of welding than intermittent welding and therefore causes more distortion. There are many other causes of distortion that can be corrected by proper designing or detailing.

Certain commonly used types of stiffeners and other details are very inadequate to resist distortion. Structural arrangements involving stiffening of plating in only one direction can often be improved, at no additional over-all cost of construction, to resist distortion better and to function more efficiently as structural elements.

Correctives

Sharp local kinks, bends and buckles frequently can be removed most effectively by cold straightening or by hot straightening, using jacks, saddles, strongbacks, rail benders, rolls, maul and flatter, etc.

Most of the distortion caused by welding can be removed by flame straightening done with an oxyacetylene torch, usually accompanied by a water spray, or air and water spray to speed up the work. This method has come into universal use in shipbuilding.

A very common mistake made in flame straightening is to heat to too high a temperature and to heat more area than is necessary. When flame straightening is being used independent of mechanical means, nothing further is accomplished by heating beyond a temperature that will just barely begin to show a little color.

Most users of flame straightening over-"shrink" by applying too much total heat. This overheating is wasteful and it causes secondary distortion often in other parts of a structure, which may not show up at once.

—La Motte Grover, Paper, *Amer. Welding Soc.*, Oct. 1942 meeting.

PANGBORN ENGINEERING AIDED U. S. INDUSTRY PREPARE TREMENDOUS RESERVES OF WAR STOCKS REQUIRED FOR THE 2ND FRONT OPENING IN AFRICA

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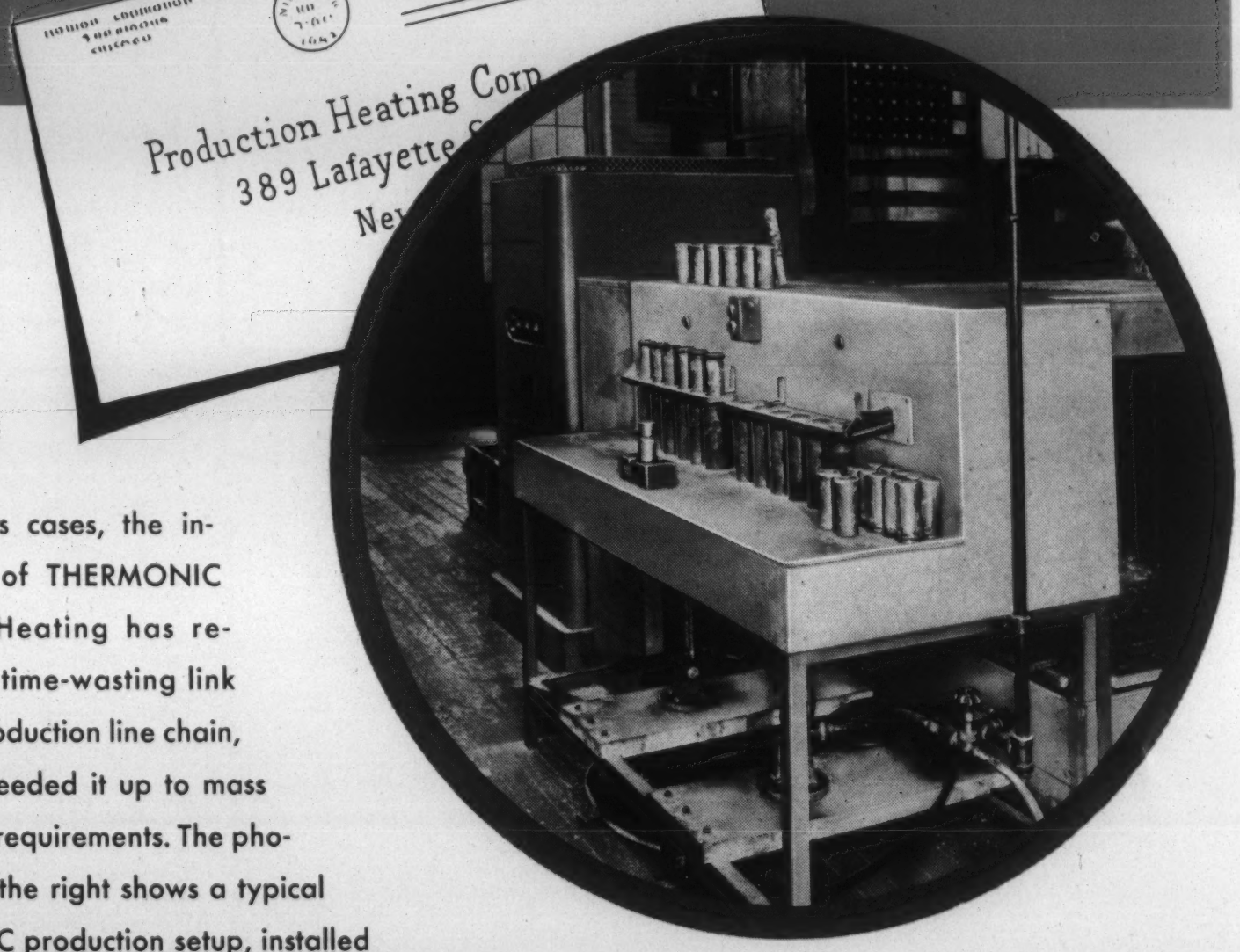

In numerous cases, the introduction of THERMONIC Induction Heating has removed the time-wasting link from the production line chain, and has speeded it up to mass production requirements. The photograph at the right shows a typical THERMONIC production setup, installed at the [redacted] plant, turning out 15,000 brazes on [redacted] in a 20 hour day. Plants from coast to coast are using THERMONIC equipment in order to keep up on their production schedules. Why not use the wealth of "production" experience possessed by the THERMONIC Research and Development Engineering Staff to solve your next production problem?

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Cast Iron Pipe Flanges

Condensed from "Heating, Piping & Air Conditioning"

The increasing use of steel flanges on almost all piping work has created a "bottleneck." Unprecedented war demands for steel have now made this acute.

The only solution is to use steel only where service conditions make its use mandatory. For all other services, cast iron flanges are an acceptable alternate.

Cast iron screwed flanges and cast iron lap joint (van stone) flanges are available for operating conditions which do not exceed 250 lbs. per sq. in. saturated steam pressure and in most cases where the service does not exceed 450 deg. F. maximum. Both are available in sizes from 1 in. to 24 in. in the 125 and 250 lbs. per sq. in. pressure classes. If prefabricated pipe is purchased, it is an advantage to specify the refacing of screwed flanged joints.

The flange is made up tight until the end of the pipe projects beyond the face. A light refacing cut is taken across the face and the end of the pipe. This provides an excellent gasket bearing surface to the inside of the pipe. It also produces perfect alignment of the flange face at 90 deg. with the center line of the pipe.

In addition to the regular cast iron conforming to ASTM specifications A 126 for Class A castings, lap joints are obtainable made of higher strength cast iron for Class B castings. This is known as semi-steel.

Care must be taken in bolting up any lap joint equipped with a cast iron flange to prevent breakage. Heavy bolt loads or sledge bolts cannot be applied.

Cast iron flanges should never be used on the ends of any type of expansion pipe bend. They are not recommended for lines handling hazardous fluids or where fire hazard legislates against their use. Code limitations concerning pressure and temperature in using cast iron flanges must not be exceeded.

—G. W. Hauck, *Heating, Piping & Air Conditioning*, Vol. 14, Oct. 1942, pages 615-616.

Wear of Metals and Alloys

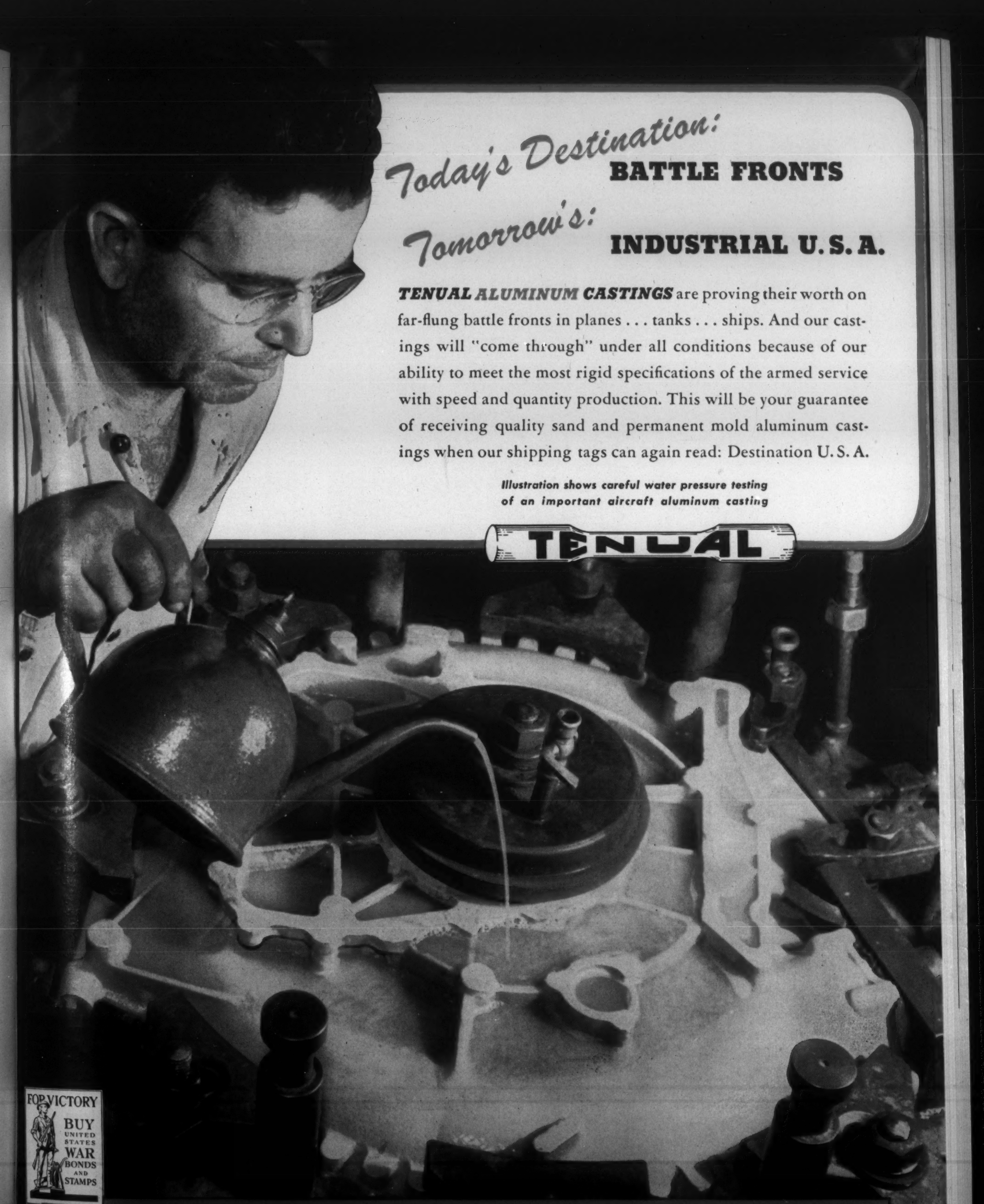
Condensed from "Metallurgia"

Wear that involves failure of metals in service causes continual replacement of parts and additional consumption of power to overcome frictional resistance.

To counteract this new steels and wear-resisting alloys have been introduced. Steels and cast irons have been subjected to special hardening processes; new bearing metals have been developed and new lubricants used.

Wear usually takes place in two stages. In the first, the "running-in" period, a chemical, physical or mechanical modification of the surface forms a polished or work-hardened layer. This is removed in the second stage by frictional forces.

In abrasive wear, usually caused by contact with other metals or solid particles, mechanical distortion of the surface layers results in structural changes. With corro-



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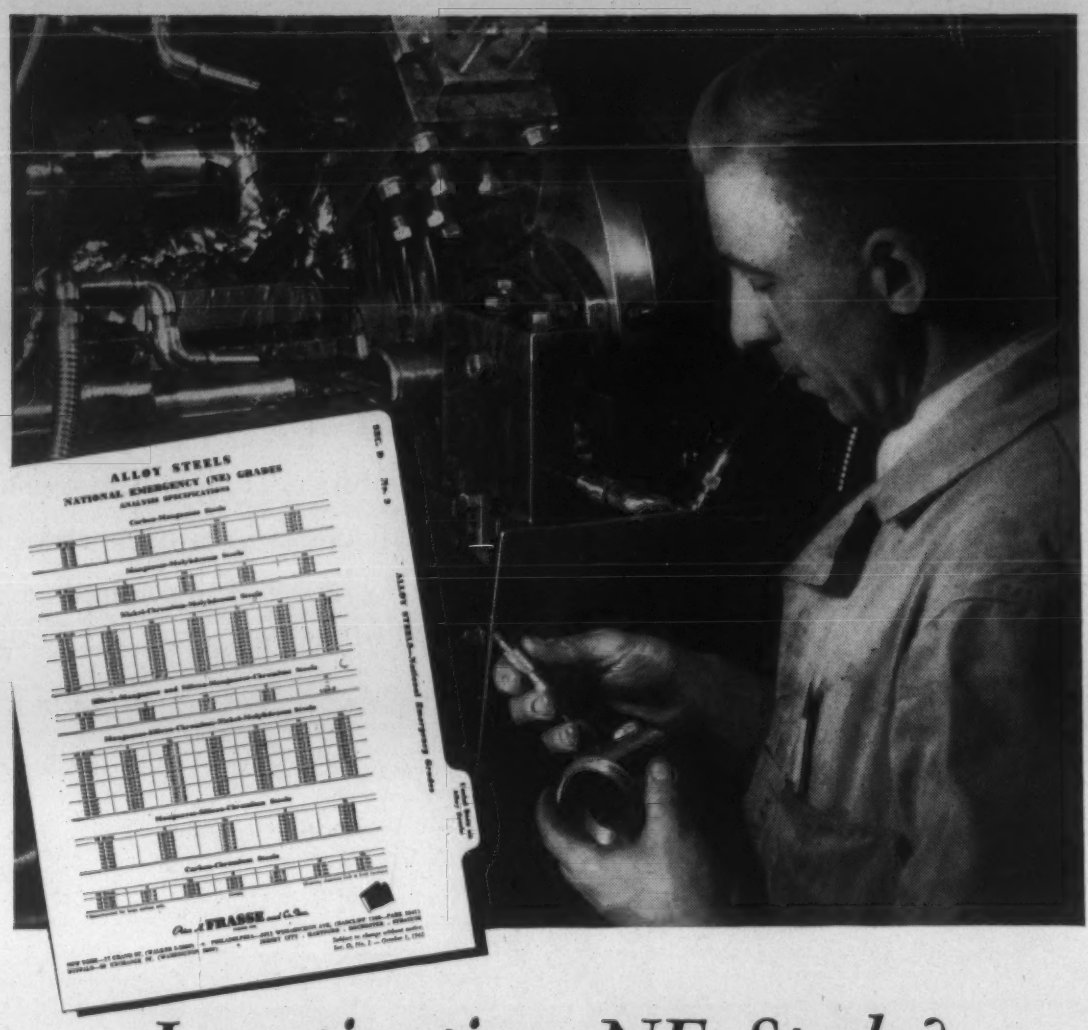

Investigating NE Steels?

Here's new, helpful data for you!

Already adopted in many war plants, NE steels will be increasingly used to substitute for standard alloy grades. If you are now testing or contemplating the use of NE steels, you'll find this new Frasse chart a handy guide.

Latest of the Frasse Data File series, it shows a complete list of recently revised NE analysis "specs", plus recommended alternatives for standard alloy steels. Both standard and NE grades are grouped, for convenience, according to approximate hardening values.

The chart is regular file size—just right for desk or wall, too. There's no charge—just mail the coupon below. Meanwhile, if you have a specific question regarding the use of these new grades, write or call *Peter A. Frasse and Co., Inc., 17 Grand St., N. Y. (Walker 5-2200) • 3911 Wissahickon Avenue, Philadelphia (Radcliff 7100 - Park 5541) • 50 Exchange St., Buffalo (Washington 2000) • Jersey City, Hartford, Rochester, Syracuse.*

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sion and erosive wear which may occur between a liquid, gas or vapor, there is usually alteration by chemical attack or attrition. Wear by galling, seizing or scoring, caused by loose metal particles or metal projections sliding against each other, involves molecular adhesion or cohesion of the two bearing surfaces.

What Causes Wear

In general, wear resistance and simulated service tests show that (1) metallic wear is proportional to bearing pressure and sliding speed, (2) wear resistance is a function of the coefficient of friction, (3) the hardness of a metal or alloy often bears no relationship to its wear and the type of lubricant, and (4) the method of lubrication greatly affects wear.

Ideal conditions are approached if the fluid film of the lubricant has no chemical action on the metallic surfaces, if it is free from suspended solid matter and if it is viscous. Investigations show that the coefficient of friction may vary from 0.002 for well-lubricated surfaces to 0.85 for unlubricated. In boundary lubrication, where the film is reduced in thickness and portions of the surfaces touch, values from 0.08 to 0.2 are obtained.

Fatty oils form stronger and more viscous layers than mineral. Where other properties do not allow the use of fixed oils, compounded oils and oils containing a small proportion of fatty acid are superior to mineral oils.

One of the chief causes for breaking down under boundary lubrication is the high temperature produced by surface areas in sliding contact. Lubricants with a high volatility and graphite with a high melting-point should give satisfactory results.

Types of Wear

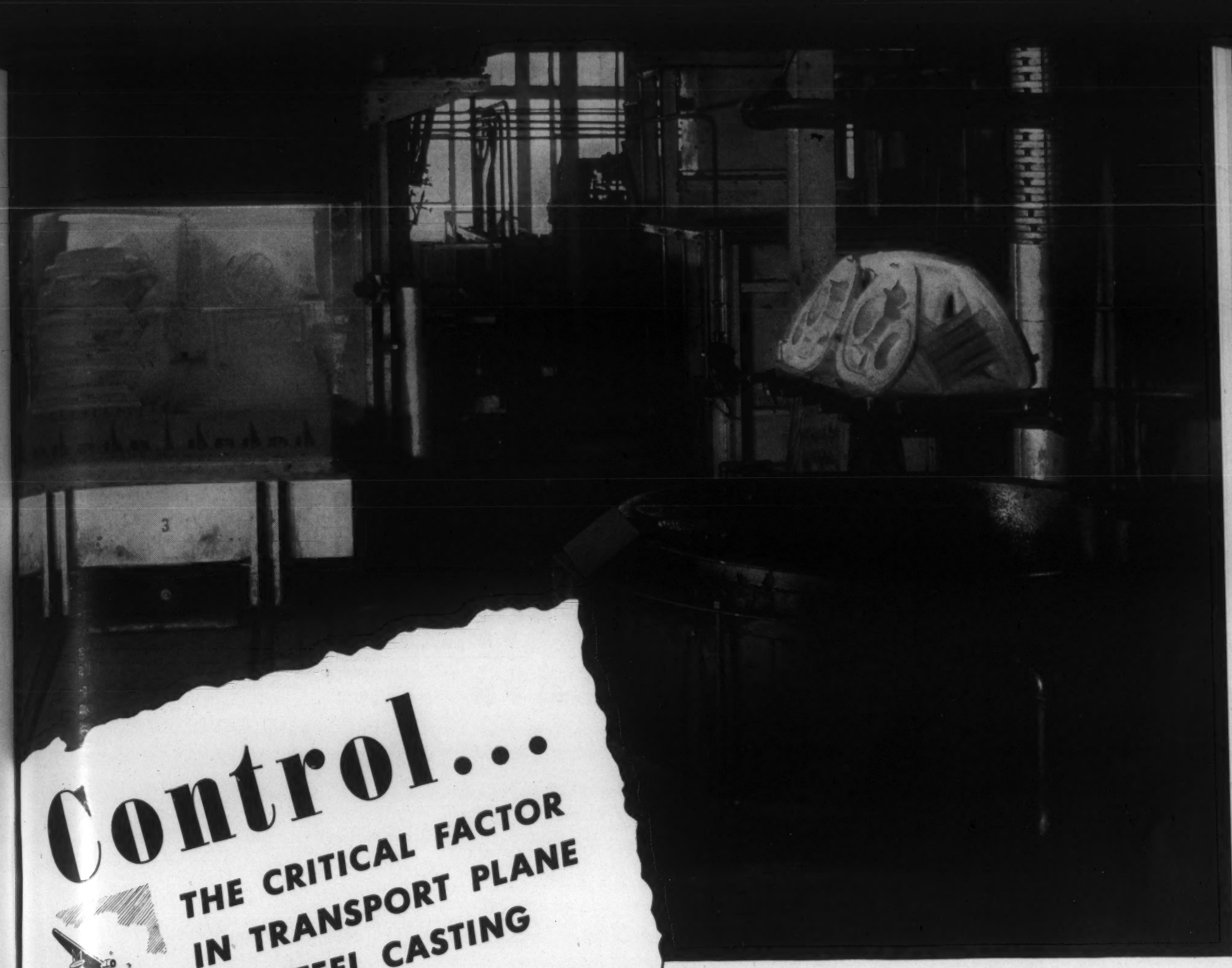
Initial wear, taking place during the running-in of surfaces, depends on the degree of roughness left by machining operations. "Run-in" surfaces consist of an "amorphous" layer formed gradually from metallic particles.

Cylinder wear in automobile and heavy oil engines is a combination of chemical and mechanical factors in which the chemical predominates and is best counteracted by the use of hard corrosion-resisting materials, with adequate and proper lubrication.

Oxidation wear is caused by the formation of an oxide film which causes increased friction. It takes place on polished surfaces in sliding contact or rolling with a slight slip between the surfaces, if the surface pressure is too low to remove metallic particles on a large scale. Exposed stainless steel surfaces oxidize at considerable speed, causing loss of weight, but when operating in nitrogen no measurable wear is found.

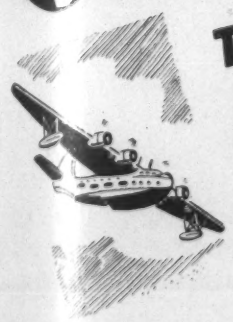
Frettage corrosion, a form of oxidation wear taking place in parts attached to each other where there is minute movement, is of a mechanical rather than chemical character. Lubricants modify but do not prevent it.

Soft materials tend to seize and harder materials to produce corrosion or oxide debris. A process of molecular attrition possibly closely connected with fatigue is



Control...

THE CRITICAL FACTOR IN TRANSPORT PLANE OR STEEL CASTING



WHEN the transport plane ferries its cargo of men or materiel across the skies, lives or equipment hang by delicate threads of control. For the heart of the huge freighter of the clouds lies not in the wingspread or motor, but in the instrument panel.

In this war, control plays a part it never before achieved . . . and plays it not only on battlefields and transportation routes but also on the industrial front where equipment is made.

The Lebanon Steel Foundry stresses control practices in the production of Circle Ⓛ Castings. One of the most important of these practices is heat treatment. The heat treatment of every Circle Ⓛ Casting is controlled to meet definite physical specifications.

Lebanon adapts the method of heat treatment to the size, shape and composition of the casting. Practices include normalizing . . . annealing . . . liquid quench (in water or oil) . . . and tempering. Castings just removed from the heat treating furnace and about to be oil quenched are shown in the photograph. Lebanon heat treating furnaces, of various types, are equipped with the most modern temperature controls.

Because Circle Ⓛ Castings play vital roles in American war operations, Lebanon considers it a duty to pay the premium casting soundness demands . . . control of foundry practice at every possible step. That's why Circle Ⓛ Castings are worthy to serve such foremost industrial organizations as Terry Steam Turbine and Lukens Steel.

Lebanon metallurgists have had close contact with war production requirements since the beginning. Their experience in solving today's type of industrial problem is available to interested organizations.

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CALLITE CONTACTS help CLARE MIDGET RELAYS do a giant's job

War intensifies the engineer's constant fight against weight and space. Every ounce, every inch, meets the toughest kind of "squeeze play" In assisting the C. P. Clare & Co. solve the problem of designing a midget relay that would do a giant's job, Callite produced silver *contacts* of small size, of precision uniformity, and extraordinary abuse-resisting stamina. Today, Callite-equipped Clare Relays are vital fighting parts of planes, corvettes, tanks and other powerful weapons.

When similar contact problems confront you, Callite will gladly assist in finding an efficient solution. Catalog No. 152 describing C-T screw, rivet and welding-type contacts is now available.

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suggested rather than ordinary mechanical abrasion.

Seizure, which takes place between chemically clean surfaces moving in contact at ordinary temperature, is caused by seize-shear action. Plastic metals seize readily on themselves and on similar single-phase metals. Hard metals are much more resistant. Seize-shear action is limited by slip planes in the metal.

Materials to Resist Wear

Although two materials of about the same hardness may have different rates of wear, in general, alloys with a high hardness are more resistant to abrasion. The retention of hardness at high temperatures is important.

New processes that produce hard surfaces of a higher degree than those obtained by carburizing are: nitriding of alloy steels; induction hardening, inside and out, of steel and cast iron parts; flame hardening of outer surfaces; hard surfacing with low- and high-alloy steels, non-ferrous alloys and tungsten and boron carbides; and hard chromium plating.

Work hardening of rolling or sliding surfaces helps to reduce wear. Hadfield's manganese steel develops a high wear-resisting surface in service as do carbon steels such as are used for railway tyres and rails. High abrasive loads produce wear-resisting surface layers in nickel-chromium cast irons.

——J. W. Donaldson, *Metallurgia*, Vol. 25, Sept. 1942, pages 155-160.

Is Tin in Steel Harmful?

Condensed from "Metals Technology"

The effects of tin on steel have become increasingly important because of the necessity of using poorly detinned scrap in the open-hearth; with a 50 per cent scrap charge of tin cans, it would be possible to have up to 0.75 per cent Sn in the steel.

Additions of 0.01, 0.02, 0.04, and 0.06 per cent Sn were made to ingots of a 0.08 per cent C rimming steel. These ingots could be rolled on a continuous hot strip mill to 0.093 in. with no evidence of checking and were later cold reduced to 0.040 in.

Tin segregated in the same manner as sulphur but not to as great a degree. In the hot rolled strip, the Rockwell B was increased 0.6 points and the tensile strength 300 lbs. per sq. in. for each 0.01 per cent Sn. As cold reduced and annealed, the hardening effect of tin was not so marked; there was also no apparent effect on ductility.

Additions of 0.1, 0.2, and 0.3 per cent Sn were made to ingots of semi-killed structural steel and rolled to ½-in. plates. All finished plates had a good surface, but the 2 ingots with the greatest amount of tin showed checking at the blooming mill. The tin segregated as indicated above.

Tests on longitudinal annealed samples showed that 0.01 per cent Sn increased the tensile strength 200 lbs. per sq. in., yield strength 150 lbs. per sq. in., while decreasing the elongation in 8 in. by 0.09

Advertisement

DECEMBER, 1942

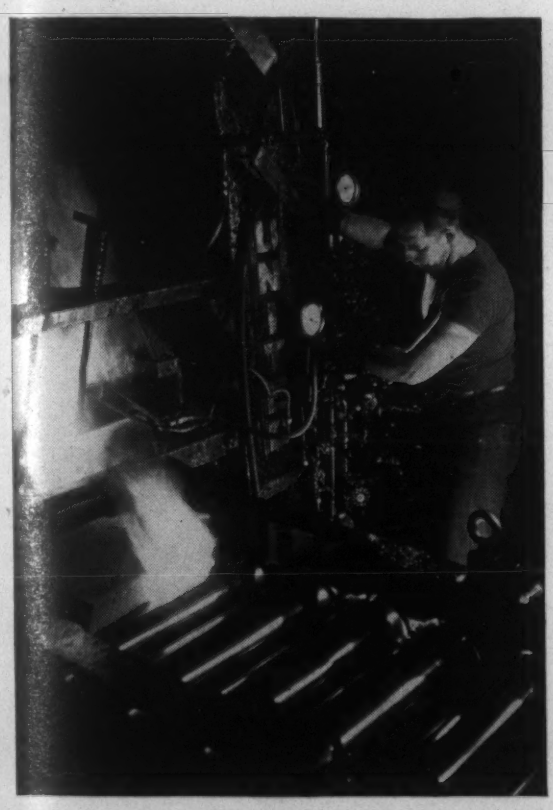
COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by the Bridgeport Brass Co. "Bridgeport" BRASS CO. *Headquarters for BRASS, BRONZE and COPPER*

Memos on Brass—No. 33

The corrosion resistance, ductility, case of fabrication and great strength which characterizes brass has made this alloy so vital to the nation's war effort that every possible step should be taken to conserve it. War Production Drive technicians estimate that one man, by neglecting to save his brass chips after a lathe job, can throw away fifty pounds of brass in a month—the equivalent of 950 .30-calibre cartridge cases.



Typical of Bridgeport's modern equipment is the gigantic hot roll shown above that transforms glowing metal billets into long slender strips from which the highest quality cartridge brass and copper sheet are produced for America's war machines. Today such up-to-date equipment coupled with exacting laboratory control and thorough testing methods are maintaining Bridgeport quality in an all-out effort for Victory.

TOP THAT 10% BY NEW YEARS!

★

Bridgeport workers have been awarded the Treasury Department "T" flag for subscribing 10% of their weekly payroll to buy War Bonds.

★

Hard Drawn Duronze V Alloy Offers Improved Cold Heading Results

High Strength, Remarkable Malleability of Copper Silicon Aids Fabrication of Nuts, Bolts, and Airplane Tubing

Duronze V, an alloy of 98% copper and 2% silicon, is playing an increasingly important part in the war effort because it facilitates the fast production of cold headed parts and assures a product that will stand up under the severest service conditions.

This alloy was especially developed for the cold heading of high strength bolts with large heads. Moderately strong in the annealed condition, Duronze V attains a very high tensile strength after severe reduction by cold drawing. Yet its Percent Reduction of Area (see graphs below) remains virtually unchanged, which serves to explain the unusual malleability of this alloy in the hard drawn condition—an important factor in the fabrication of cold headed parts. Unlike many other high copper silicon bronzes which are difficult to process, Duronze V is more ductile than drawn brass wire.

Heat Treatment Unnecessary

Duronze V is supplied in the form of hard drawn wire with a tensile strength between 90,000 and 100,000 pounds per square inch. This wire can be formed by cold heading and roll threading into bolts that average as high as 120,000 pounds per square inch. No intermediate or relief anneals are required. Further, such bolts are not weakened by shearing stresses and do not have to be given a final heat treatment if properly headed.

Another important advantage of Duronze V is that it is not subject to season or corrosion cracking. For this reason, parts made from it are excellent for outdoor construction. Duronze V, for example, is widely used in the manufacture of wire and cable connectors, pole-line and marine hardware, upset nuts, bolts, caps, machine and wood screws.

Airplane Tubing

Duronze V is also supplied in the form of tubing which is used for oil lines on airplanes and for tubular rivets in overhead catenary construction. Because of its strength and corrosion resistance, it is also recommended for automatic heaters, conduit and other conditions requiring a corrosion-resistant material stronger than copper.

CHEMICAL COMPOSITION OF DURONZE V

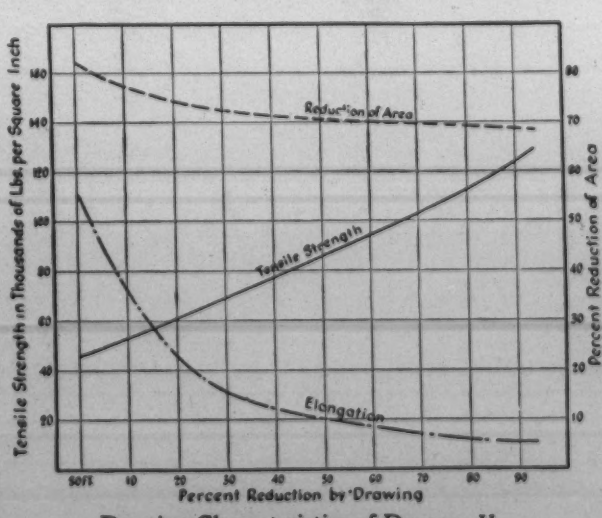
Copper	98%
Silicon	2%

PROPERTIES OF DURONZE V

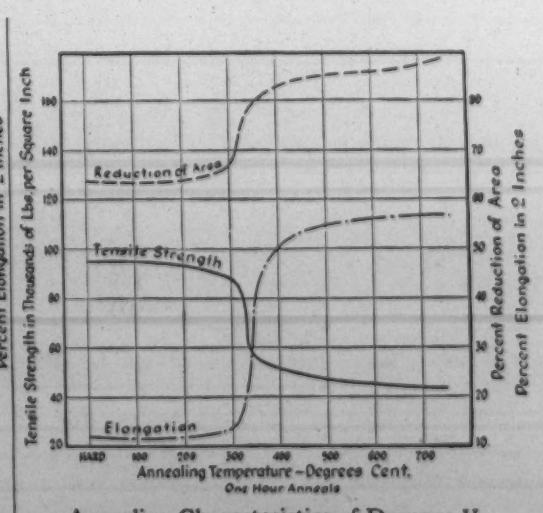
Electrical Conductivity	9.0%
Density—Lbs. Per Cubic Inch	.313
Modulus of Elasticity	15,000,000
Coefficient of Thermal Expansion per Degree F.	0.0000093

Duronze V wire meets the following specifications: Federal QQ-C591—Copper Silicon Alloy Rods, Class B; A.S.T.M. B98-41—Copper Silicon Alloy Rods, Type B; and A.S.T.M. B99-41—Type B Wire.

Any questions on the properties or fabrication of Duronze V will be gladly answered by the Bridgeport Brass Company.



Drawing Characteristics of Duronze V



Annealing Characteristics of Duronze V

CAUSES OF CORROSION

ELECTROCHEMICAL THEORY OF CORROSION

This is the second of a series of articles by C. L. Bulow, research chemist at Bridgeport Brass Company, discussing some of the fundamentals of corrosion as applied to numerous common failures occurring in service.

The rate of the reactions discussed in this column last month is determined by the slowest of the reactions under a given set of conditions. For example, the reaction $M + H_2O \rightarrow MOH + H$ for iron is the fastest and the reaction $2H + O \rightarrow HOH$ is the slowest under many commonly occurring conditions.

Several investigations have shown that the rate of corrosion in natural water is almost directly proportional to the oxygen content. In a closed system such as a hot water heating system in a home, the corrosion becomes negligible after the oxygen has been gradually removed. The rate at which the reaction proceeds also depends upon the character of the metal, hydrogen ion concentration (called pH), temperature, etc.

The detection of the corrosion products (metal hydroxide, hydrogen or water) resulting from these reactions varies with the corroding metal or alloy and corrosive solution. The hydroxides of the active metals, for example sodium and potassium, are very soluble in water and will not reveal their presence for some time, but the evolution of hydrogen is very rapid and the reaction is violent. The hydroxides of the less active metal, such as iron, are only slightly soluble in water and quickly reveal their presence as white or reddish brown ferrous and ferric hydroxides. The removal of metal ions from the solution by the formation of an insoluble or soluble corrosion product permits the reaction $M \rightarrow M^+ + e$ to go forward. Sometimes other materials present in the water coprecipitate with the slightly soluble hydroxides and form a more or less protective coating on the surface of the metal. A small quantity of dissolved carbon dioxide in water takes part in the formation of a practically insoluble green basic copper carbonate, such as is found in copper piping in service for some time, which greatly retards or stops the corrosive reaction.

In the presence of salts, such as sodium chloride, (5) becomes more complicated:

$$(9)\quad M + H_2O + NaCl \rightarrow MCl + NaOH + H$$

$$(10)\quad \underline{MCl + NaOH \rightarrow MOH + NaCl}$$

$$(11)\quad M + HOH \rightarrow MOH + H$$

(Continued in column 2)

Hot Forging Process Aids War Production

Where intricate parts with excellent physical properties must be produced rapidly in large quantities, such as in many war plants today, the hot forging process offers special advantages.

Forgings, for example, are stronger, less porous, and more accurate in dimensions than sand castings. In addition, their surfaces are smoother and cleaner, thus facilitating the process of polishing and plating.

A valuable aid to the speedy, economical production of forgings is Bridgeport Forging Rod. Being highly plastic when hot, it fills the die easily and, in addition, is free machining.

Zinc Content Linked To Brass Corrosion

Recent reports of the soil-corrosion investigation being conducted by the National Bureau of Standards with specimens of various materials suggested for underground use substantiate previous findings on the low corrosion rate of copper, and point out that there is a fairly definite relation between corrosion and the zinc content of a series of brasses.

"Except in a tidal marsh soil, the corrosion rate of the copper-zinc alloys increased generally with the zinc content," the report, which covers six varieties of copper and four copper alloys, states. "The copper, however, corroded in a soil high in chlorides, but this soil had relatively little effect on the Admiralty metal and the 70:30 copper-nickel alloy, as would have been predicted from the resistance of these materials to corrosion by sea water. The behavior of the brasses in the tidal marsh containing sulfides was unique in that the corrosion rate decreased with increasing zinc content, the reverse of the normal order."

CAUSES OF CORROSION

(Continued from column 1)

However, these reactions (9 and 10) overlap so that a mixture or compound of metal hydroxide and chloride called a metal oxychloride is formed on the metal surface. In this instance, the reaction $2H + O \rightarrow H_2O$, still remains the controlling factor as already described.

NEW DEVELOPMENTS

An automatic chute feed has been put on the market which is claimed to increase production of two-spindle profiling machines as much as 30 per cent, when added to the air chuck. The maker says that this attachment is being used for feeding such items as brass and copper and copper primer tubes for boring and tapping operations on both ends at the same time. **(No. 390)**

A pneumatic vise has been designed with foot control. As many as 1200 operations per hour are said to have been made in it. The vise is operated by multiple-type diaphragm. A movable jaw has a maximum travel of ½ inch, gripping with a force of 15 times air line pressure. An adjustment screw enables the jaw to be set with an opening up to 3 inches. The vise can be used on pressures up to 150 pounds per square inch. **(No. 391)**

An angle protractor has been developed which, it is said, can be used to measure any large or small surface angle to provide a direct reading on the angle and its component. The maker says it can be used to measure taper in shallow blind holes. Graduations on the sliding scale permit taking depth measurements. **(No. 392)**

A chuck is offered for gears from 3 to 36 inches in diameter which is said to be suited for use with single or cluster spur or helical gears. It employs a number of hardened pins that hold the gear at its pitch line. The pins are backed up by cams assembled on a ring that is turned to grip or release the work. Tightening is against the normal direction of rotation. **(No. 393)**

A hand-operated marking unit has been put on the market for cylindrical parts such as shell noses. The part to be marked is placed over a mandrel in front of a slide carrying an engraved die. A lever rotates the mandrel and slides the die laterally at the same time. The depth of impression is adjustable and mandrels of various sizes are interchangeable. **(No. 394)**

A steel wool is announced to remove burrs from sides and edges of non-ferrous metals. In ribbon form four inches wide, it is wound on a spindle that mounts in the chuck of a drilling machine. The pad is said to be resilient, to reach into irregular openings, and to return to its original form after the part has been removed. The wool and spindle are available as a unit, or the wool alone can be supplied. **(No. 395)**

A cleaning liquid is offered for removing grease and dirt from metal parts. Mixed with water, it is applied at 130 to 160° F. It is said to remove heavy coatings of mineral oil and to leave a minute film on the surface which acts as a rust preventitive. **(No. 396)**

A non-metallic mallet with a plastic head has been introduced for use on soft metals such as copper, brass, aluminum and sheet steel. The maker claims it resists wear, does not deteriorate, and is rodent-proof. **(No. 397)**

This column lists items manufactured or developed by many different sources. Further information on any of them may be obtained by writing Bridgeport Brass Company, which will gladly refer readers to the manufacturer or other source.

PRODUCTS OF THE BRIDGEPORT BRASS COMPANY

Executive Offices: BRIDGEPORT, CONN.—Branch Offices and Warehouses in Principal Cities

SHEETS, ROLLS, STRIPS—*Brass, bronze, copper, Duronze,* for stamping, deep drawing, forming and spinning.

CONDENSER, HEAT EXCHANGER, SUGAR TUBES—For steam surface condensers, heat exchangers, oil refineries, and process industries.

*Trade-name.

PHONO-ELECTRIC* ALLOYS—High-strength bronze trolley, messenger wire and cable.

WELDING ROD—For repairing cast iron and steel, fabricating silicon bronze tanks.

LEDRITE* ROD—For making automatic screw machine products.

"Bridgeport" BRASS CO.

Established 1865

COPPER WATER TUBE—For plumbing, heating, underground piping.

DURONZE ALLOYS—High-strength silicon bronzes for corrosion-resistant connectors, marine hardware; *hot rolled sheets* for tanks, boilers, heaters, flues, ducts, flashings.

BRASS, BRONZE, DURONZE WIRE—For cap and machine screws, wood screws, rivets, bolts, nuts.

FABRICATING SERVICE DEPT.—Engineering staff, special equipment for making parts or complete items.

BRASS AND COPPER PIPE—"Plumrite"* for plumbing, underground and industrial services.

Note: Bridgeport products are supplied in accordance with existing priority regulations.

BRIDGEPORT BRASS

INDUSTRY IS ON AN EIGHT-DAY WEEK

Seven days a week America is doing one of the greatest jobs of production the world has ever known. We are living with one part of that job here at Alcoa, where over seventy thousand men and women are producing Aluminum in quantities that were mere fantasy yesterday.

But there's an eighth day tucked in among the few open spaces in the seven-day week. Engineers are able to squeeze in some important Imagineering about post-war products—planning that will help convert war jobs into peace jobs.

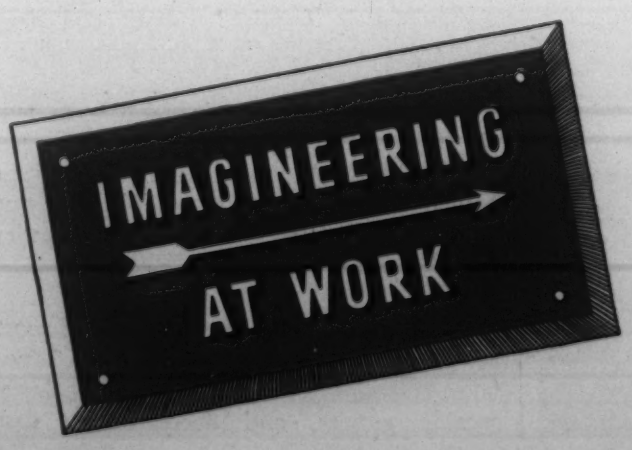
For instance:

Imagine what 1,000 pounds less weight in the automobile of the future would mean in performance, gas economy and tire life. Then engineer it down to the realization that 1,000 pounds *can* be taken off by using, say, 500 pounds of Aluminum per car.

Now translate possibilities such as these into your own business.

Aluminum costs less today. New methods, techniques, processes, and new forms of metal coming out of the war effort will all be available for the as-yet-untold possibilities in tomorrow's peacetime products and peacetime services.

Our eighth day is devoted to helping Imagineers throughout industry use the potentialities of Alcoa Aluminum in bettering the new ideas they are dreaming up. ALUMINUM COMPANY OF AMERICA, 2162 Gulf Building, Pittsburgh, Pennsylvania.



ALCOA ALUMINUM

Little things

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★ SMALL LEAD SPECIALTIES are important in the production of aircraft, ships, tanks, and Army and Navy Ordnance. Alpha is supplying standard lead alloys as well as special lead parts ready for use on the assembly line in these industries.

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OFHC Copper conforms to the A.S.T.M. Specifications for electrolytic copper wirebars, cakes, etc., B5-27 with regard to metal content and resistivity, and is free from cuprous oxide.

OFHC Copper is characterized by its freedom from casting defects and its bar-for-bar uniformity. Its freedom from oxygen results in great ductility and toughness as evidenced by its high reduction of area and resistance to impact. OFHC Copper withstands more working in hard condition when tensile strength is greatest, making it especially suited for products subjected to severe fabricating or service conditions.

THE AMERICAN METAL COMPANY, LTD.
61 Broadway, New York, N. Y.

per cent and the Charpy impact by 0.40 ft.-lbs. Tin had somewhat less effect in the hot rolled condition.

Additions of 0.02, 0.04, 0.07, 0.10, and 0.20 per cent Sn were made to ingots of induction melted 1040 steel (McQuaid Ehn 2-4), which were hammered down and tested as normalized and after water quenching from 1550 deg. F. and tempering at 1000 deg. F. (air cool from temper). Again, there was a slight hardening effect.

The elongation figures were erratic, but there was a sudden drop in reduction of area (as-quenched and tempered from 46 for the tin-free steel to 30.8 per cent) and a sudden decrease in Charpy (as-quenched and tempered from 20 for the tin-free steel to 15 ft.-lbs.) between 0.104 and 0.227 per cent Sn rather than the steady uniform decrease noted above. Tin had no effect on the Jominy.

Additions of 0.05, 0.08, and 0.11 per cent Sn made to a 0.77 per cent C rail steel caused a slight increase in Brinell hardness, yield strength, and tensile strength, but had no apparent effect on elongation and reduction of area. However, a bend test (¾ x 2 in. section bent around a 2-in. pin) showed a steady decrease in angle to failure with increasing tin.

These small amounts of tin could not be detected in the microstructure, although the steels with tin had a slightly finer grain size (actual, not McQuaid Ehn) than the tin-free steels. A special 0.28 C, 1.5 per cent Sn steel (very difficult to forge) showed a precipitate in the grain boundary (probably carbides). It is believed that the effect of tin on ductility may be somewhat like temper brittleness, since a normalized and tempered 0.41 C, 0.227 per cent Sn steel had a ductility (including Charpy) almost equal to tin-free steel if it was water quenched from the tempering temperature.

—J. W. Halley, *Metals Tech.*, Sept. 1942, T. P. 1513

Working Properties of Plastics

Condensed from "Product Engineering"

General forms of raw plastic materials are liquid, powder, solid and laminated. Liquid "casting plastics" are available in unfilled phenol formaldehyde, acrylate and polystyrene. All plastic materials are available in powder form. Solid materials are those cast in standard shapes and sizes. They are available in many extruded sections.

Laminated plastic is in solid form with sheet fillers of paper, linen, canvas or spun glass. Phenol-formaldehyde and urea-formaldehyde plastics are used for this purpose. Plywoods are not considered plastics.

Fillers

Properties of plastics are governed mostly by the type and amount of filler. Wood flour and similar fillers create bulk, lower specific gravity, and decrease the cost.

DRIVING 'EM OR *BUILDING 'EM!*

IN PURDY, war plants can find an organization that knows steel problems and talks and thinks about them in the language of production. When standard materials and procedures don't work out or can't be used, Purdy men are right there with practical ideas to get the job done—and they can draw on the complete line of PLANET drill rod, tool steel, spring steel and cold-drawn steel to see it through.

Tanks, trucks, planes or guns—whatever you're making today, if you have a problem in steel supply or application, or a tough angle that demands extra ingenuity in using steel, call on Purdy for quick action.

A. R. PURDY CO., Inc., 792 Greenwich St., New York, N. Y.

PLANET Polished Drill Rod is one Purdy product that "talks" production language too. Commercial grade—1.00 Carbon. Finish ground and annealed. For dies, reamers, rollers, drills. (Sizes from .013 to two inches.) All sizes in 3-foot lengths, many sizes in 12-foot lengths.

Special Drill Rods: Choice grade—1.15/1.25 Carbon. Best for higher-type work, sharper edges, finer tools. Particularly good for punches. (Sizes from .024 to 1.5 inches.) Carried in 3-foot lengths.

Flat Drill Rods: High grade — 1.00 Carbon tool steel. Lime drawn and annealed. For former parts, gravers, dies, punches, cutters. Sizes of flats from 1/16 by 1/32 to 1/2 by one inch, of squares from 1/16 to one inch. Carried in 3-foot lengths.

Simonds "Red Streak" Flat Ground Stock, made from Annealed Tool Steel and ground within limits of plus or minus .001 inch. Square on both edges and ends. Saves time in making jigs, gauges, templates and tools. Sizes from 1/64"x4" to 1" Square.

War steels PLUS *Know how* . . .

Mineral fillers increase heat and electrical resistance, produce hardness, improve anti-friction properties and sometimes increase compressive strength.

Fibres increase flexural, impact, shear, and other strengths. Macerated fabric or cordage increase shock resistance and flux-ural strength.

Fabrication Processes

Molding processes are classified as:

1. Compression molding, comparable to press-forging of metals.

2. Injection molding, comparable to die-casting of metals. Transfer molding, a name applied to injection molding of thermo-setting materials, requires more complex heating and control.

3. Special process molding, required when plastics contain high-strength fillers.

Casting methods are economical for quantities from 50 to 1000, not more. Liquid materials only are used. There are no size limitations. Filler and coloring may be added as desired. Fibre inserts may be used.

Extrusion methods are used for most thermoplastic materials although cellulose acetate butyrate is generally considered proper. Extruded plastic is soft.

Fabricating Operations

All machining methods used on metals and most used on woods may be employed. As filled plastics are likely to be abrasive, designs should not require close machining.

Shear type blanking operations may be used on plastic sheets up to 0.12 in. thick. By an additional operation, thermoplastic materials, when heated, may be sheared in thicknesses up to 0.30 in.

Standard minimum machining tolerance is ±0.010 in. Tolerances of ±0.002 in. in lathe work, ±0.004 in. in mill work, and ±0.001 in. by grinding are possible. Thermoplastics are heat formable. Sheets may be drawn or formed at 200 or 300 deg. F. Closed sections may be hot formed by hydraulic or pneumatic pressure.

Assembly Methods and Finishes

Plastic designs should incorporate their own attachment means whenever possible. Hollow or spun rivets may be used. Self-tapping screws, drive screws, or serrated bushings are possible.

Cementing and solvent fusions are practical for permanent assembly. Thermosetting materials generally must be fused with the aid of a solvent.

Surface finish of molded plastic can be any degree of smoothness desired. A high gloss should not be attempted where there is filler. Paint, varnish, etc. may be applied directly to thermosetting materials. Some thermoplastics require special protection.

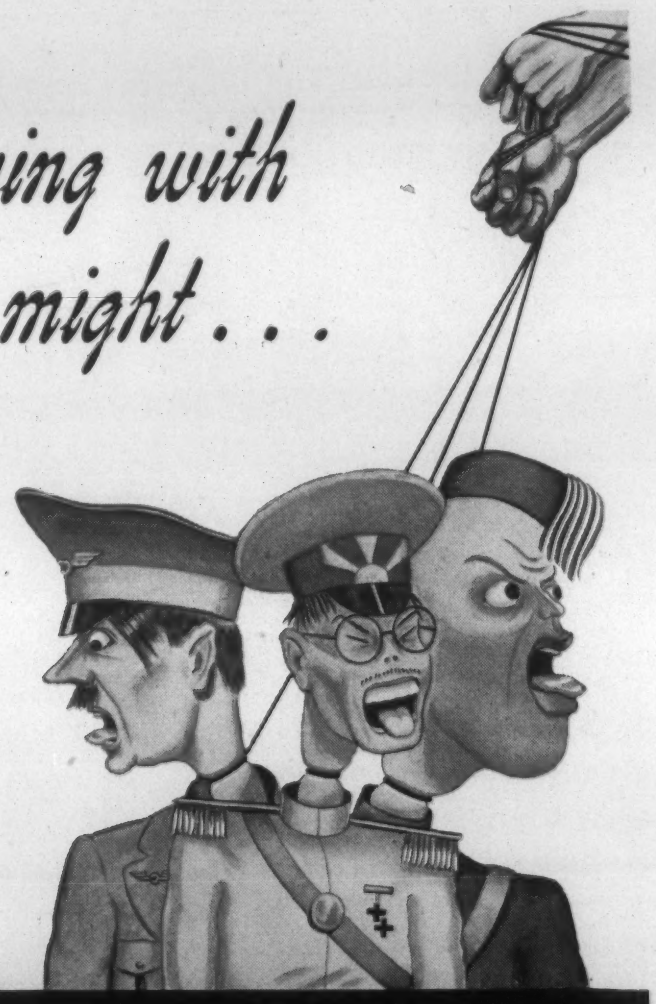
Inserts or underneath articles which change the desired color may be printed. Metal plating may be applied to all plastic materials.

Special Materials

High tensile materials such as Nylon and Saran have tensile strengths as high as 80,000 lbs. per sq. in., in a given direction. Various plastic films are available that will resist all materials except concentrated nitric acid or the turpine oils in citrus rinds. Heat dispersing surfaces may be produced by laminating a layer of brass or aluminum mesh below plastic surfaces.

—Horace C. Hillman, *Prod. Engineering*, Vol. 13, Oct. 1942, pages 584-587.

Drawing with all our might . . .



Continuously working at capacity, we are truly "drawing with all our might!" We are proud that Wilbur B. Driver Co. special alloys have so many vital war applications and of the part they are playing toward the final complete strangling of the "Unholy Three".

Perhaps we can help you make your product do its part more effectively or get on the job more quickly. Consult us for your requirements.

WILBUR B. DRIVER CO.
NEWARK, NEW JERSEY

Saving Copper in Electric Units

Condensed from "Electrical Manufacturing"

To continue to produce electrically energized products, we must do more with less copper. Military experts are considering equipment built for admittedly short life. There are three ways of attacking the problem:

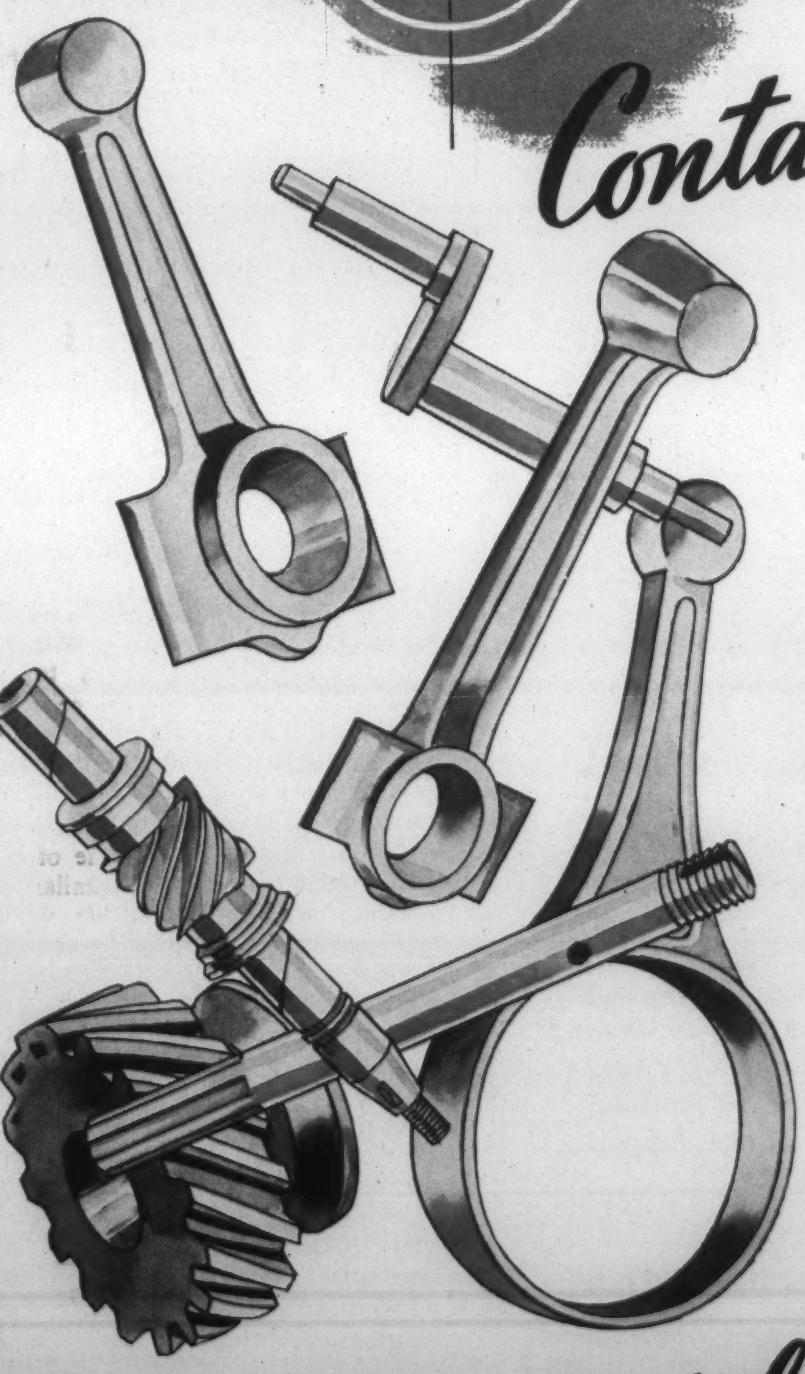
1. Raise the operating temperature of electrical devices. The temperature limit determines the size of copper and iron parts which in turn fix the dimensions of auxiliary parts.

2. Redesign electro-magnetic devices. Within limits, iron and copper proportions are adjustable and up to now the available margin has not been utilized.

3. Remove copper from current-carrying parts now made heavy for mechanical reasons. For the same strength, most steels are lighter than copper alloys, and in some

Weight Reduction . . .

Plus EXCEPTIONAL BEARING PROPERTIES *with* 600 BEARING METAL



Contains no tin!

• 600 Bearing Alloy is the solution to many difficult bearing problems. It is for the "hard-to-crack" applications. It can be drawn or forged and readily fabricated in a great variety of sizes and shapes. It is approximately three times stronger than the best cast bearing bronze, and develops a lower temperature under heavier loads and higher speeds. Extreme pressure lubricants do not corrode it.

Primarily where a bearing is subjected to a reciprocating motion, reduction in weight is essential to keep vibration at a minimum and to assure maximum efficiency. Because 600 Metal is stronger per unit of weight, parts can be made of equal strength out of 600 Metal with a REDUCTION OF 10% TO 35% IN THE WEIGHT OF THE FINISHED PART.

600 Bearing Metal has been successfully used for the past 14 years for:

Gears • Gear Blanks • Bushings • Bearing Pins Connecting Rods • Worm Gears • Cams • Thrust Washers • Propeller Shafts • Drive Shafts Super-charger Shafts • Truck Transmissions Drawn Rods • Extruded Shapes • etc., etc.

600 is a superior metal for higher speeds at light loads or for slower speeds at heavy loads, running against hardened, well-finished shafts. Fourteen years of successful use has shown hundreds of applications where 600 has proved immeasurably better than the materials commonly used.

600 BEARING ALLOY HAS SUPERLATIVE BEARING PROPERTIES, BUT CONTAINS NO TIN; THUS CONSERVING THIS CRITICAL METAL FOR THE WAR EFFORT. THIS IS AN ADDED REASON FOR ITS ADOPTION AND INCREASED USE.

Write us if you have a bearing problem or for additional information.

Specify 600 metal!

MUELLER BRASS CO.

PORT HURON, MICHIGAN

applications steel might carry all the current needed.

Coils

It might be advantageous to change from dc. to ac. coils which usually contain less copper for a given open-jaw pull. Any mechanical advantage which lightens the duty should be investigated.

In control devices where the mechanical mechanism and the current carrying main circuit parts have often been combined, it may be necessary to separate the functions and use steel for rigidity or strength and a minimum of copper in the form of shunts to carry current. A composite structure may serve. Copper-clad steel in several ratios and in many shapes is now available.

Using silver for contact surfaces to avoid oxidation dangers, the temperature of bare current carrying parts may be allowed to double.

In designing transformers there is a wide permissible band of adjustment between the weight of iron and copper. Going as far up in volts per turn as possible without upsetting too much the insulation, reactance, etc., permits less copper and more iron.

In power distribution, where 75 per cent average loading is common, the unit may be proportioned to allow for loss of copper at that rate rather than at 100 per cent.

"Iron Motors"

In series dc. motors, the trend is toward an "iron motor" in place of lightweight construction.

In the armature, the slats are narrower than the teeth. The mean length of turn for armature coils is reduced, because with the same diameter, a shorter core is possible. There is increased efficiency.

If there is any temperature margin, the field coils can be allowed to run hotter. On the interpoles, the number of turns is less because there are fewer ampere turns in the armature.

In the commutator of a dc. motor, the problem is the surface provided for current collection. Copper-clad steel might be adequate provided the fabrication could be worked out and the co-ordinated problems of segment insulation and mechanical elements provided for.

The limitation with small motors may be the permissible starting current as the "iron motor" may have lower reactance and resistance of the stator. This is often unimportant for war equipment.

Induction Motors

Test motors have been built to run at high temperatures and a saving of one-half the usual copper seems possible. Insulating coverings which have withstood operating temperatures of 200 deg. C. are available. The subject of lubricants has to be studied. Differential expansion of parts is another difficulty.

Even a 10 per cent saving of copper now used would build 11,600,000 motors of standard design.

—Douglas F. Miner, Section 3, *Elec. Mfg.*, Vol. 30, Oct. 1942, pages 121-123, 200-202.

"AMPCO" Bronze Worm Gears Stand Up Under Heavy Loads . . .

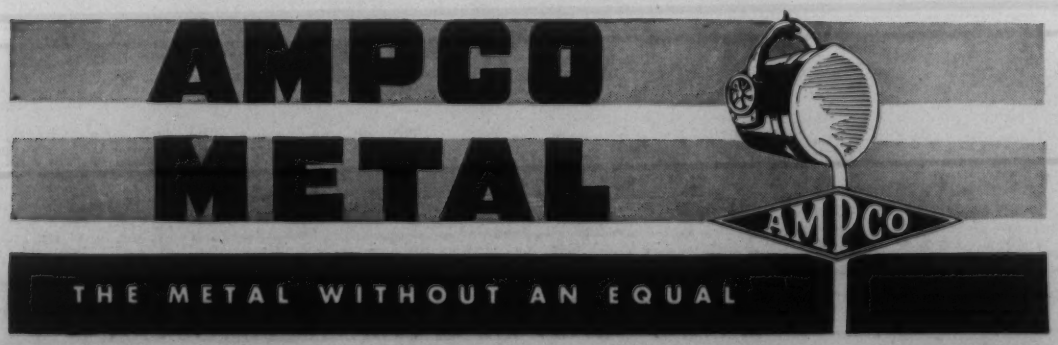
Microstructure of Ampco Metal, Grade 18-23

In Marine service — often miles at sea where breakdown cannot be tolerated —Ampco gears stood up month after month and showed no signs of wear. Here again the bronze proved its merit under tough service conditions.

Ampco Metal grade 18-23, has all that is needed in a gear bronze—bearing properties; correct microstructure; shock resistance; strength under dynamic loading; and hardness to resist brinnelling and deformation under extreme load conditions. It has proved itself under varying applications to be an outstanding bronze for gear service, and is backed up by 28 years experience in alloying bronze. . . . Thoughtful plant executives will investigate Ampco Metal. Ask for free bulletin "Ampco Metal in Gears."

AMPCO METAL, INC.

DEPARTMENT MA-12 MILWAUKEE, WISCONSIN

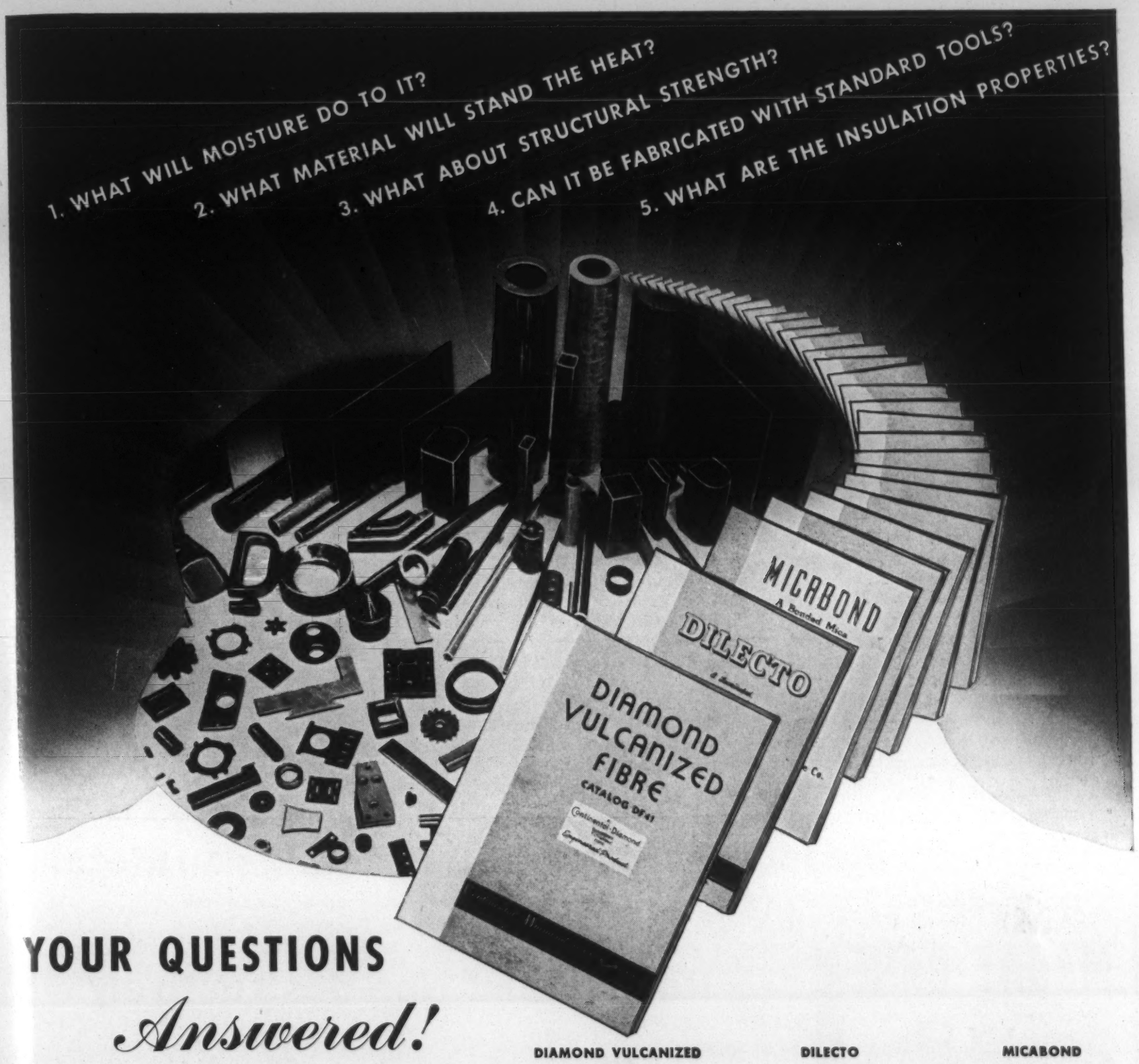


Malleable Irons

Condensed from "Canadian Metals & Met. Industries"

The possibilities are discussed of the application of "blackheart" malleable cast iron in the war effort. "Blackheart" malleable cast iron is an iron which, as originally cast and of the proper composition, is extremely hard, brittle and with a white fracture; then by subjection to a heat treatment known as annealing or malleableizing, it is subsequently rendered soft, ductile and with a black fracture. "Blackheart" malleable cast irons from the air furnace, the cupola or one of the duplexing methods are very similar.

The annealing operation, in which the metal "as cast" is heat treated to yield the soft ductile product is accomplished by two methods. The original method entails packing the "hard iron" castings into metal boxes or "pots" (omitting the active material that is added in the manufacture of "whiteheart"). The boxes, covered and hermetically sealed, are placed in ovens or kilns which are then closed up tightly, The oven is next heated to a temperature of 1650 to 1750 deg. F. This temperature is maintained, depending upon the size of the oven and the total weight of the charge, for a period of from 40 to 60 hrs., then allowed to cool slowly to approximately 1250 deg. F., after



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THREE new catalogs on Continental-Diamond NON-metallics . . . new informative illustrations . . . comprehensive technical data as to properties . . . suggestive explanation of new uses. Any one . . . or all three . . . of these new catalogs may help you solve your present "What Material?" problem. Write today.

CONTINENTAL-DIAMOND FIBRE COMPANY
24 Chapel Street **Newark, Delaware**

	DIAMOND VULCANIZED FIBRE	DILECTO	MICABOND
1	Has a natural affinity to moisture . . should be used where not exposed to moisture . . . paraffine coating is effective under low voltage conditions.	Is non-hygroscopic.	Practically unaffected by moisture.
2	Suggested maximum working temperature 350° F.	Grades available that will satisfactorily withstand 300° F. to 450° F. depending on grade and applications.	Heater plate will withstand 900° F.
3	It's tough, strong and resilient. Tensile 7500 PSI; Compressive 25,000 PSI; Flexural 12,000 PSI.	Has very favorable weight-strength ratio in comparison with other insulating materials.	Should not be used as supporting member, except flatwise.
4	Sheets, rods, tubes readily fabricated on standard tools, at high speeds and fast feeds.	Is readily fabricated with standard tools to close tolerances, and will retain dimensions under unfavorable operating conditions.	Requires special handling technique. Best procedure is allow us to furnish fabricated parts.
5	Dielectric; Avg. 175 VPM.	⅛" material; grades available which will test 350 VPM.	Grades available which will top 450 VPM.

Continental-Diamond FIBRE COMPANY

Established 1895 . . Manufacturers of Laminated Plastics since 1911 — NEWARK • DELAWARE

which the oven can be opened gradually and allowed to cool faster. This method of annealing is known as the "periodic." Although the quality of the metal annealed by this process is very satisfactory when precautions and control are employed, the annealing process is rather lengthy and time consuming.

In the second method the development of continuous type, controlled-atmosphere furnaces, either gas or electrically heated, with various zones of closely controlled temperatures is a feature. The complete cycle requires 18 to 36 hrs. Most blackheart malleable cast irons contain 0.08 to 0.10 per cent S, and 0.30 to 0.35 per cent Mn. Coincident with the changes taking place during the annealing, a certain amount of carbon gradually is eliminated from the immediate surface of the casting, resulting in a decarburized surface or "skin." Outstanding physical properties of blackheart malleable cast iron are its ability to resist shock and a fair resistance to corrosion.

When protected by a hot-dip galvanized coating, it possesses decidedly superior corrosion-resistant qualities under a variety of conditions. The addition of copper in amounts up to 2 per cent has been found beneficial in increasing the resistance to certain forms of corrosion without affecting the other properties to any extent. Industrial uses of malleable castings cover a very wide range.

Pearlitic malleable cast irons are distinguished from the blackheart type by the character of the matrix. It contains some carbon in the combined form, whereas blackheart iron contains, generally, only a minute quantity of it.

—*Can. Metals Met. Inds.*, Vol. 5, Aug., 1942, pages 238-241.

Silver for Bearings

Condensed from "The Iron Age"

For smooth and continuous operation bearings must possess: Oiliness; embedability (ability to "soak up" grit); resistance to corrosion; high melting point; strength; ease of bonding; and seizure resistance (ability to maintain a continuous fluid film of lubricant).

A recent development is the application of silver bearing to connecting rods of airplane engines. These bearings have all the essential properties required for heavy duty.

The frictional properties of silver bearings were tested in an Amsler wear-tester. Results showed that alloying additions tend to reduce the seizure pressure, indicating that pure silver was the most satisfactory.

In engine tests records made by pure silver were variable. The "deficiency in oiliness" of pure silver can be remedied by using it only with a polished shaft. In order to improve the oiliness of silver bearings, there have been suggested: (1) The addition of small amounts of lead; and (2) blending the oil with an addition agent, such as sulphur.

Details of silver bearings for aircraft engines are not available, but it is known that they are composite products of silver facing on a steel back. The bearing must consist of silver of not less than 99.75 per cent electroplated on the steel back. After plating, the bearings are heat treated to 900 to 1000 deg. F. for 1 hr.

Silver-lead alloys were found to have the best bearing qualities, except for ease of bonding. The alloy giving the best results contained 3 to 5 per cent Pb and balance silver. Up to 1.5 per cent Pb exerts a slight hardening and strengthening effect. From 1½ to 5 per cent, little effect is noticeable.

If the lead content is high it segregates upon freezing at grain boundaries causing weakness and intergranular cracking, especially at high temperatures The maximum lead content that can be used without cracking is between 3.68 and 4.68 per cent. The alloy may be applied without thermal segregation by electro-deposition or "cold casting."

The advantages of electrodeposited bearings are (1) It is a cold process that leaves unaffected the hardness of the steel backing; (2) the scrap loss is at a minimum; (3) the deposit can be applied on any part of the bearing, inside or outside of the backing; and (4) the deposit has a uniform, fine-grained structure, which on annealing gives softer plates with higher seizure resistance.

—Adolph Bregman, *Iron Age*, Vol. 150, Aug. 13, 1942, pp. 65-67; Aug. 20, 1942, pp. 41-45.

AMINCO-BRENNER **Measures Thickness Of Coatings on Metals**

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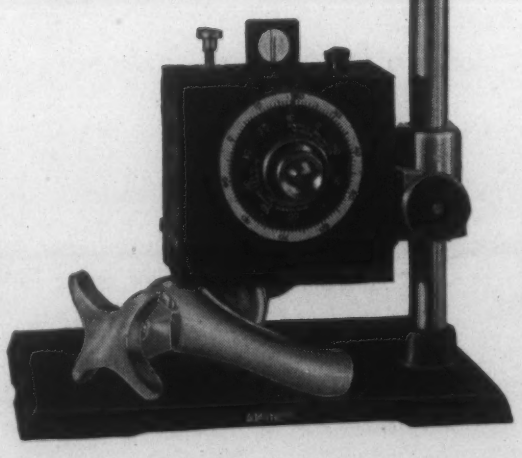

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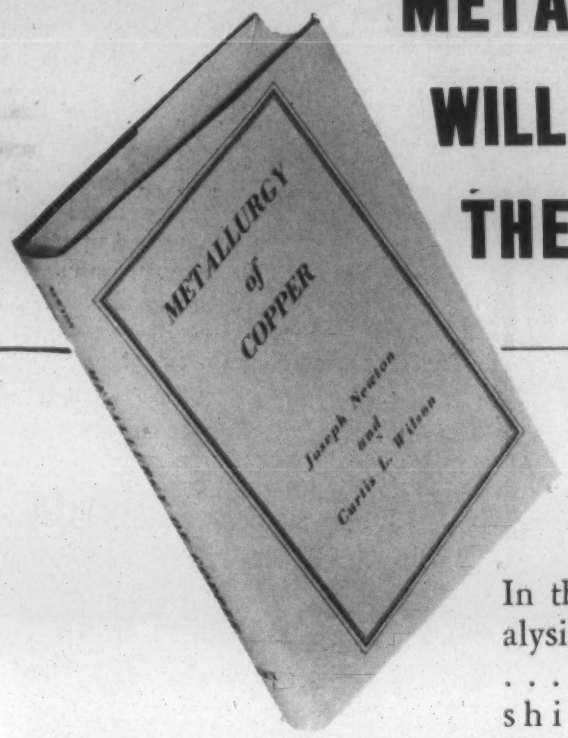

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File Hardness Testing 1170
Electropolishing of Carbon Steels 1170
Magnetic Powder Inspection for Sub-Surface Flaws 1172

Coating-Thickness Tests

A Composite

The rapid and accurate measurement of the thickness of surface coatings is an important war-production problem, for coating thickness is a frequently specified item and the tolerances are seldom generous. Two recent articles, one on production-type gages used in America for rapid thickness testing and the other on a Russian device for measuring the thickness of non-magnetic coatings, are thus of timely interest.

Rapid Thickness Measurement

Quick methods, mostly of an "electrical" nature, for measuring the thickness of coatings and of some whole sections of metals are described by E. S. Gallagher (*Amer. Machinist,* Vol. 86, Oct. 15, 1942, pages 1155-1157). In wartime, control over thickness of coatings as well as of wall thickness of non-ferrous materials is of even greater importance than in peace time, since many metals, such as chromium, nickel and tin, are restricted and must be used as economically as possible with no allowance for any factor of uncertainty.

Gages for such measurements operate on the principle of a reactance type bridge circuit. A 115-V, 60-cycle power supply is normally used although other power sources may also be employed. If the gage head which has an iron core reactance is placed on a bare piece of steel, a magnetic field is set up in the steel; then the coil reactance can be balanced against a companion balancing reactance, so the indicating instrument reads zero.

When a similar but coated piece of steel is substituted, the thickness of the coating acts as an air gap in the circuit, changing the coil reactance of the gage held by an amount indicated by the instrument, the scale of which may be marked with arbitrary figures or in inches enabling the user to make his own most satisfactory calibration.

Uses include measurement of linings (lead-bronze, copper, silver, or heavy Babbitt), 0.005 to 0.050 in. thick, of crankshaft and connecting rod bearings; of chromium, nickel or cadmium plating to increase wear or corrosion resistance of steel parts; of protective copper film used to prevent carburizing or nitriding of parts of ferrous aircraft engine gears; wall thickness of aluminum or magnesium castings, especially those with many cored sections not accessible to the usual type of micrometer; thickness and uniformity of plastic sheets 0.004 to 0.75 in. thick; and depth of case hardening on bearing raceways. Peacetime uses included checking thickness of paint on automotive bodies, enamel on refrigerators, etc.

Biggest advantage of this type of gage is that parts being measured need not be destroyed to obtain reading.

Thickness of Non-Magnetic Coatings

S. D. Entin (*Journal for Material Testing, U. S. S. R.,* Vol. 10, Feb. 1941, pp. 126-129; translated by V. P. Akimoff in *Sheet Metal Inds.,* Vol. 16, Sept. 1942, pp. 1326-1328) describes a Russian defectoscope designed to determine the thickness of non-magnetic coatings by Eremin's

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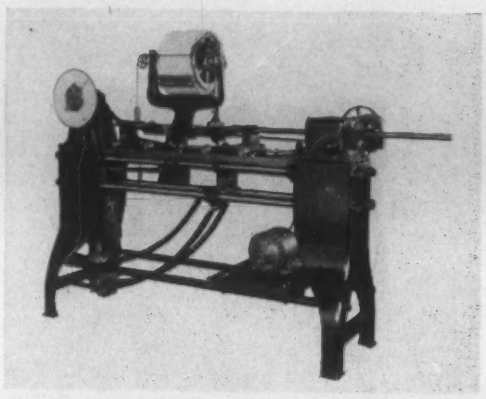

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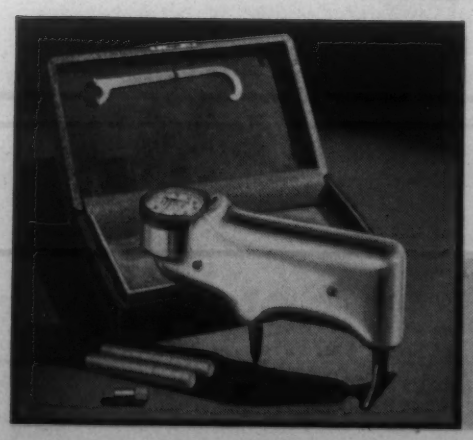

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system. It is based on the measurement of the variation in the intensity of magnetization of a long permalloy rod of high maximum magnetic remanence when it is brought close to a ferro-magnetic body magnetized by that rod itself.

The measurement is affected by the differential method with the help of two induction coils. Its fundamental part is an electro-magnetic probe that has 4 degrees of freedom and can thus be moved in any required direction. The permalloy core is brought into contact with the surface under test, after which the current is switched on.

The magnetic field thus created magnetizes the core and sets up an alternating magnetic field at the ends of the core. Under the action of this field, a small area of the steel object tested surrounding the point of the core becomes magnetized and produces a supplementary field which reacts with that of the core. The increase of induction in the permalloy at the near end of the core leads to an increase of the e.m.f. in the induction winding.

In the case of identity of structure of the metal of which the objects tested are made, the variation of the e.m.f. of induction is conditioned by the size of the gap between the core and the surface of the ferro-magnetic body; *i.e.* by the thickness of the non-magnetic coating.

The apparatus has a very high sensitivity. A coating of 1 or 2 mu causes a deflection of the galvanometer by 20-30 graduations of the scale. However, a specially graduated scale is required for every type of object to be tested, since the e.m.f. is a function of shape and thickness of the fundamental ferro-magnetic metal. The e.m.f. is also a function of the structure of the base metal and of the curvature and degree of cleanliness of the surface.

The apparatus may also be used to find cracks or flaws running in any direction as well as latent defects, such as insufficient tempering, flaws, etc. Lengthwise and crosswise faults may be simultaneously located.

Commercially, it has the advantage of operating on a.c. of 110, 220, or 380 volts or on d.c. of 60-250 volts. The high power also permits subjecting articles to cyclic magnetization by an a.c. of 4000 amp and 6 volts.

Originally the apparatus was devised for testing the quality of heat treatment of small steel articles. It can be calibrated according to the microstructure of the objects, in which case it will by the nature of its response promptly reveal any defects, either in the steel or heat treatment.

"Magnetic Photographs"

Eremin was the first to contruct a special electro-magnetic apparatus for magnetizing a polished section of ferro-magnetic material. He worked out a technique for obtaining by chemical means stable magnetic colloids with a particle size of 10^{-5} cm [details not given]. These colloids are desposited on the magnetized section and observed under 500 x magnification.

A "magnetic photograph" at 6 magnifications of a silicon chromium steel is illustrated and shown to correspond fully to that obtained by micro-etching (5x). The authors point out that the time required for a magnetic test is only 0.5-1min. as

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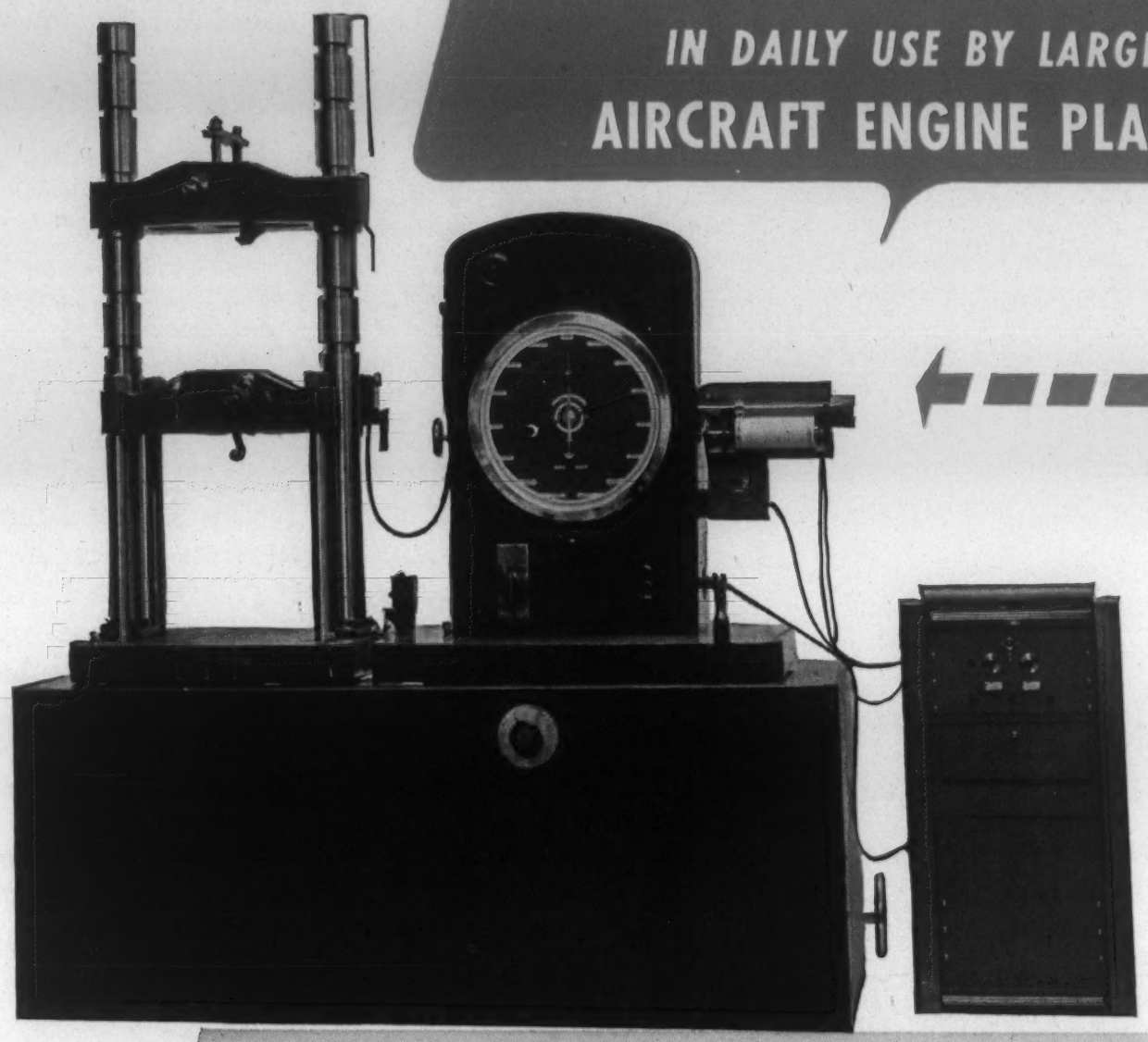

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THE SOLUTION... Micro-radiographic studies made with the G-E Model XRD X-Ray Diffraction Unit.

SAMPLES... Rolled brass strips, consisting of 65.6% copper and 33.4% zinc, varying from 0.005 to 0.015 inches in thickness, were studied by micro-radiography with the G-E Model XRD Unit.

PROCEDURE... Identical specimens were annealed for a period of six hours at the temperatures indicated in the accompanying graph.

Micro-radiograph No. 1, taken before heat treatment was begun, illustrates the condition of the hard brass sample which had a grain size of less than 0.020 millimeters.

Micro-radiograph No. 2 illustrates the changes in the sample's structure after it had been subjected to a temperature of 932° F for six hours.

Micro-radiograph No. 3 illustrates the structure which was produced when a portion of the specimen was raised to a temperature of 1300° F and annealed for one hour.

RESULT... Micro-radiography reveals that the structure of rolled brass is not homogeneous and contains portions which have high zinc concentrations. Variations in this concentration occur subject to the heat treatment, and the micro-radiograph offers a convenient means of controlling heat treatment with an absolute knowledge of the nature of the grain structure produced.

Since grain structure and porosity are directly connected with the metal's performance and machinability, micro-radiographic studies made with the G-E Model XRD Unit will help make for uniform results in manufacture.

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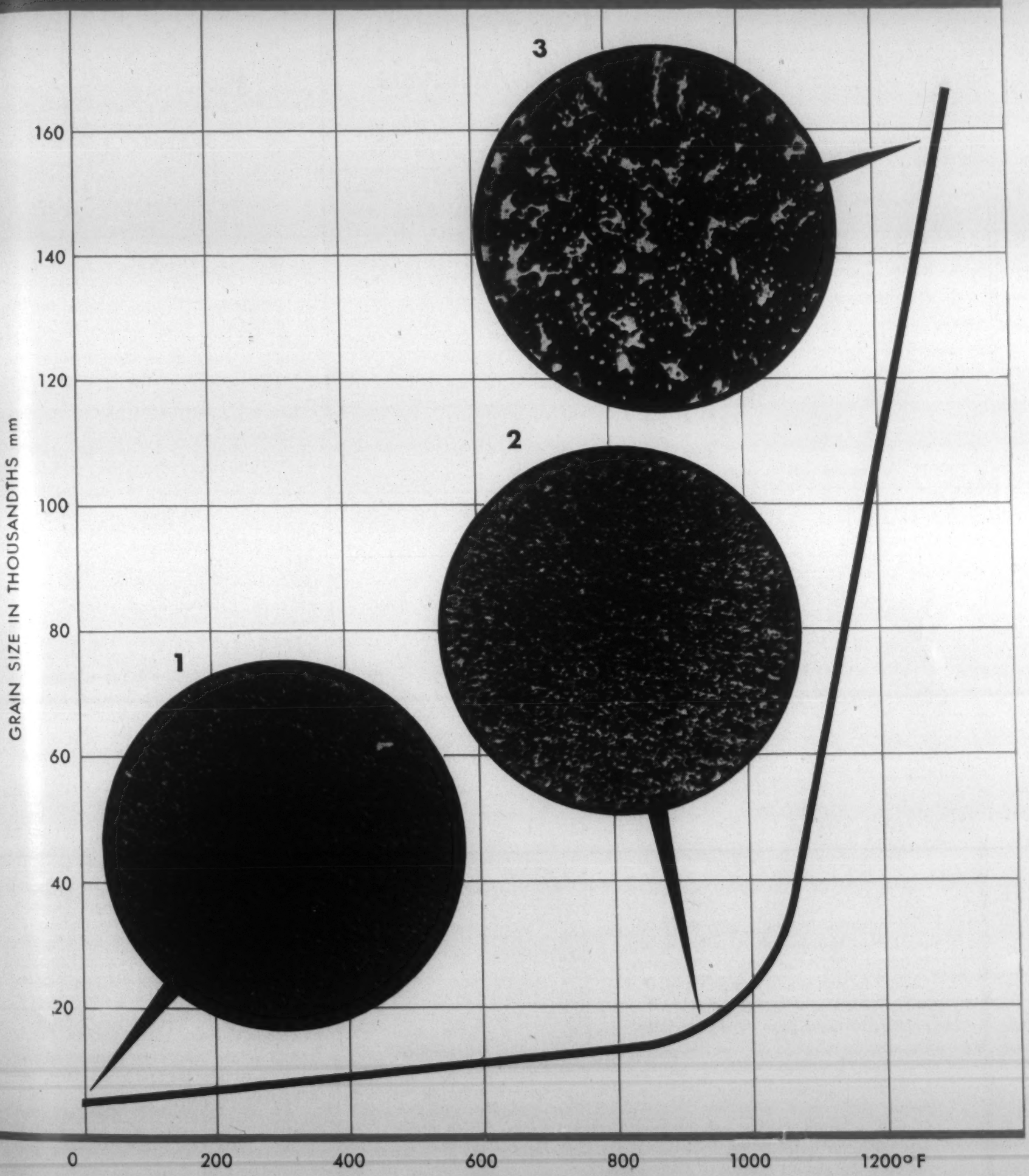
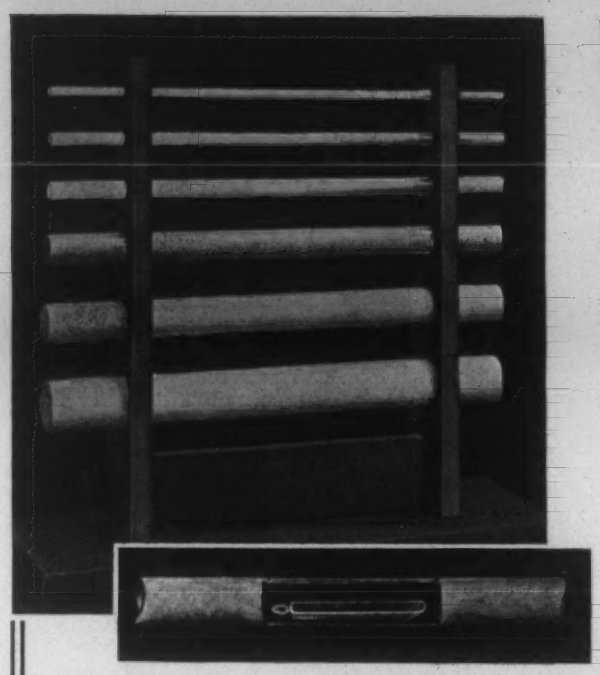
GRAIN SIZE CHANGES IN BRASS



GRAIN GROWTH IN ROLLED BRASS AS SHOWN BY MICRO-RADIOGRAPHY

(Reproduced from original micro-radiographs having magnification 500X)



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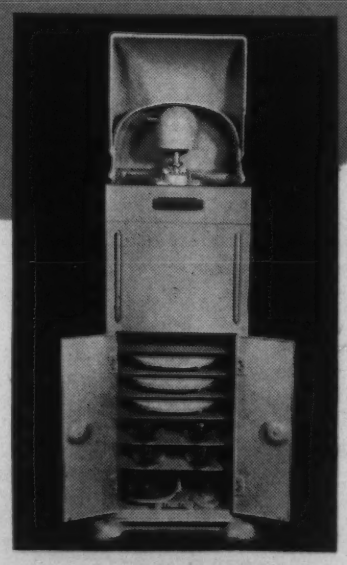

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Low operating speeds: simultaneous preparation of multiple specimens; substantial reduction in polishing time and absolute uniformity of high quality specimens are other features which make this machine outstanding in its field. . . . *Write for booklet describing the Jarrett Polishing Technique.*

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compared with 4½ hrs. for the testing of the same material by etching. [*The reason for this long time required for conventional metallographic inspection is not clear. It is much longer than would be considered necessary here*—J. Z. B.].

The author believes that the magneto-metallographic method which makes possible the extra rapid analyses of the macro and micro structure of steels and cast iron will find a wide field of application. The universal magnetic defectoscope was tried in 10 of the most important works of the Soviet Union and has met with high approval.

Bearing Oil-Corrosion Tester

Condensed from "S.A.E. Journal"

The original apparatus, developed by the Texas Co., consisted of a spinner, partially submerged in the test oil, driving the test bearing which rotated about a stationary spindle. The spinner was centered at the top by a ball-bearing and was driven by an electric motor through a dog-clutch. Baffles prevented the oil from swirling with the spinner. Later, the ball-bearing was discarded because it accumulated oxidation products from the oil and was difficult to clean.

Experience indicated the desirability of using glass breakers. Pratt & Whitney Aircraft designed a similar apparatus, retaining the original features and adding others. In this apparatus, the outside of the test bearing is used as the test surface. The test bushing is 1 in. outside diam. by 1 in. long and is made with proper running clearance in the spinner. The bearing is mounted on a stationary pin with a very slight taper, which permits releasing the bearing by tapping the bearing support. The lead surface, produced by electroplating, has been adopted for judging the suitability of oils for production test-stand use.

In the Texas Co.'s version of this apparatus, the same type of bearing is used as in the original design. In this unit, a split micarta bushing holds the bearing in a stainless-steel spinner. These bushings have internal flanges which center the bearing on the spindle and prevent contact with it. The flanges are serrated so as not to impede oil circulation. Preventing actual contact between bearing and spindle is important in obtaining reproducible results. Without this feature, bearing wear was added to corrosion loss and wear varied with slight differences in alinement.

Most of the remaining features of the two versions are identical. Complete apparatus has 10 corrosion units which may be run simultaneously. Test oils are placed in glass brakers set into an electrically heated aluminum block which can be maintained at the desired temperature. A motor at the top of the apparatus drives 10 spindles, each of which is attached to one of the spinners. Any of the spindles may be raised by hand at any time, disconnecting it from the drive pulley. Oil is drawn through the bearing clear-

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ance by the motion of the bearing, travels up the conical side of the spinner, and is discharged from holes in the top of the spinner near the periphery. Rotation of the spinner produces air circulation through the braker by drawing air in through holes near the center of the cover and discharging it through holes near the periphery. Two baffles prevent excessive rotation of the oil in the beaker.

How Tests Are Made

In testing, 125 cc. of oil to be tested are placed in each beaker. To facilitate heat transfer, space around each beaker is filled with a heavy oil. Spinners are lowered in, covers put in place, and when proper temperature is reached, spinners are revolved at 3000 r.p.m. After rotating for 2 hr., the bearing is removed; cleaned in a mixture of equal volumes of methyl acetate, toluol, and denatured alcohol, or other suitable solvents; and weighed to determine corrosion loss.

Cleaning is very important as oxidation of some oils produces resinous substances which deposit on the bearing surface to such an extent as to protect it from further corrosion. Ten-hr. runs without intervening cleaning periods have shown considerably less weight loss than on corresponding runs where bearings were cleaned every 2 hr. Further weighings are made at 4, 6, 8, and 10 hrs.

Bearings used by the Texas Co. are 5/8 in. inside diam. and 3/4 in. long, and are made from the same copper-lead-coated steel strip used for commercial automotive engine bearings. With this test, corrosion weight losses can generally be reproduced to within 10 per cent of the average value of a number of runs. Baffles may be of various materials, but copper is used and the baffles are polished immediately before each run. Tests with copper and stainless steel at 350 deg. F., showed that copper baffles reduced the induction period from 6-7 hr. for stainless steel to 2 hr. and terminated the induction period more precisely.

After corrosion starts, the rate for both materials was about the same. This indicates that catalysis, while reducing the time at which corrosion starts, has little effect on the corrosiveness of the oil after it develops. Tests with copper-lead bearings at 350 deg. F. having different structures showed that the coarser the structure, the greater the weight losses. There was little change in induction period.

Effect of Temperature

With regard to effect of temperature, no appreciable loss resulted at the lowest temperature (225 deg. F.). At higher temperatures, the induction period became shorter and the corrosion rate immediately after the induction period became progressively greater. At 400 deg. F., while the initial corrosion rate was as high as at any other temperature, this rate fell off rapidly so that, after 6 hr., total corrosion was less than at 350 deg. F. This may have resulted from rapid increase in viscosity as the oil oxidized, thereby slowing the circulation rate; deposition of material on the bearing, protecting it from corrosion; or volatile acids being driven off.

Increasing the temperature up to about 350 deg. F. increased the neutralization number, but above this temperature, a decrease occurred. Runs in which various quantities of oil were withdrawn periodically during the corrosion tests and replaced with fresh oil indicated that the only marked reduction in corrosion caused by fresh oil additions occurred when all the oil was changed at the end of each induction period.

Tests in which the bearings were changed at 4, 6, and 8 hr. but without changing the oil showed that the corrosion of each of these bearings over the subsequent 2-hr. period was nearly the same as for the original bearing during the first 2-hrs. after the induction period. This indicates that the decreasing corrosion rate normally experienced after the 4-hr. period is probably due to a reduction in lead available for further corrosion at the bearing surface and the corrosiveness of the oil after the induction period remains constant, at least until the end of the 10-hr. runs. This test gives corrosion results which correlate satisfactorily with full-scale engine tests.

Engine Tests Necessary

However, the apparatus does not eliminate the need for engine tests, as there

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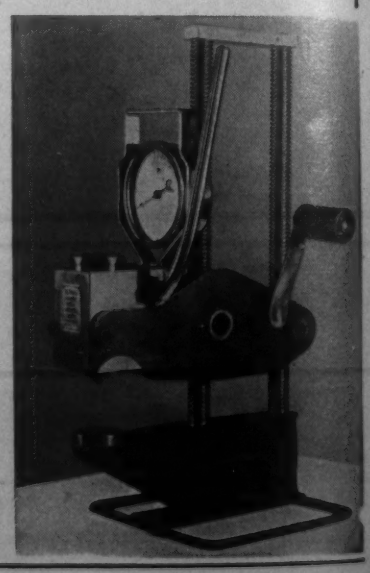

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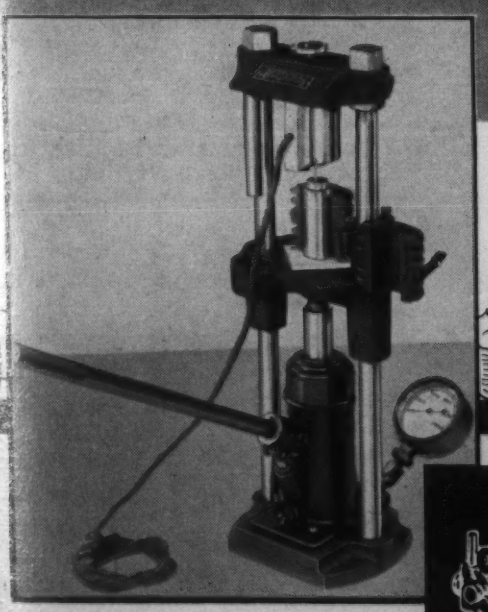

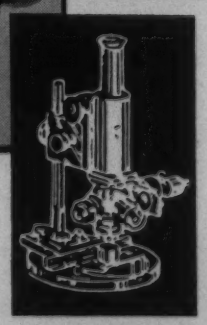

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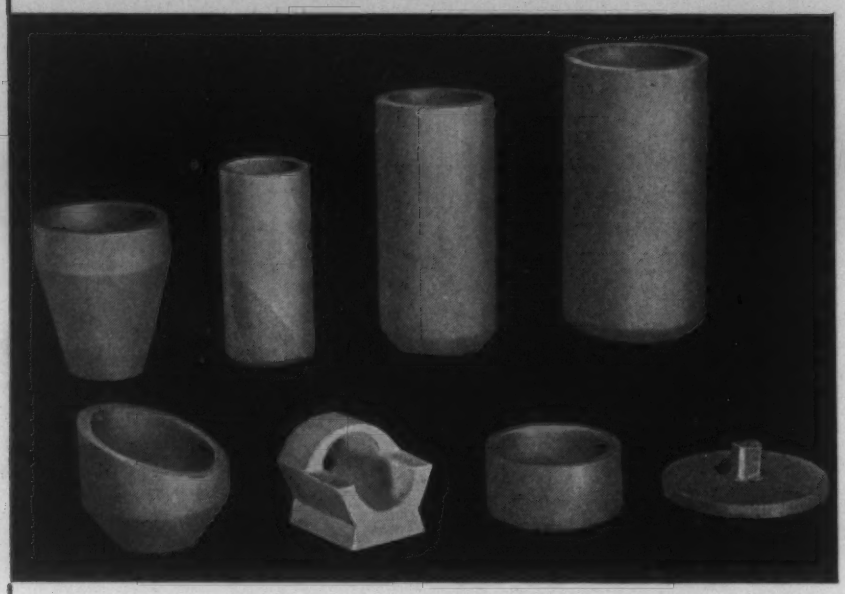

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It has been found that usefulness may only be attained if the files are comparatively small in length and cross section. The design of the file should definitely permit a checking of the file material at various spots by means of conventional hardness testing methods. This makes the pillar file of about 6 in. the most desirable.

Test files under strict metallurgical conditions were prepared as follows: Chemical composition of a previously annealed file was C-1.22; Mn-0.32; Si-0.29; S-0.023; P-0.016; and Cr-0.03 per cent. The file was broken into 1 to 1½ in. specimens and drawn at various temperatures. Cooling was in still air to 80 deg. F.

After treatment the sides were smoothed and 4 Rockwell tests made. The average of these determinations was recorded as resultant hardness for the corresponding drawing temperatures.

File tests were conducted by several operators and the average Rockwell C hardness obtained by these operators showed C-61.4 for round files, C-63.1 for flat and C-65.5 for irregular specimens. Microhardness measurements made on tips of file teeth indicate that files of C-67 Rockwell hardness will bite steel of C-64 to C-65. This difference in resistance to scratch is somewhat less pronounced at a lower hardness.

The relative file hardness is a function of the actual hardness expressible in Rockwell, Brinell, or diamond pyramid hardness of the file material. Accordingly, softer files are useful criteria for relatively softer material.

—John H. Hruska, *Iron Age*, Vol. 150, Sept. 10, 1942, pages 35-39

may be other factors tending to affect the correlation. It does permit an appreciable reduction in the number of engine tests and the "weeding out" of a large number of oils or bearing materials so that engine tests are made only on those materials which indicate promise from the point of view of corrosion.

Pratt & Whitney Aircraft has used this apparatus for testing oils whose behavior was known in aircraft engines in test-house service. Such satisfactory correlation was obtained in rating these oils in the relative order of their corrosiveness and tendency to sludge, that the apparatus is now used to distinguish between good and bad oils for aircraft engines in test-house service.

—Neil MacCoull, E. A. Ryder, A. C. Scholp, *S. A. E. Journal*, Vol. 50, Aug. 1942, Trans. pages 338-345.

File Hardness Testing

Condensed from "The Iron Age"

According to tool engineers, files are classed as edge tools. The teeth of the file must be produced from such metal and with such treatment which permit repeated use without dulling. Steel used for files consists of: C 0.90-1.40; Mn 0.25-0.50; Si 0.15-0.35; P 0.03 maximum; S 0.03 maximum; and V 0.10-0.15 per cent (if specified).

These files are usually made to "bite" material of Rockwell C-63 to C-65. Some are as high as C-66 to C-68. Production of these special files depends on the successful attainment of uniformity in surface hardness and toughness in heat treatment. The usefulness of high-grade files as testing tools depends upon certain design factors, number of teeth per inch, etc.

The purpose of test files is not to remove stock but rather the production of a multiple scratch on the test material. An analysis of the fundamentals governing the mechanics of a scratch indicates that the most important of factors is the shape and hardness of the penetrating edge. Round or square bars may be heat treated to a definite hardness, ground to a 65 to 90 deg. point and used for the determination of actual scratch hardness.

To facilitate handling of a smooth bar, it was more convenient to use a round or even square file which prevents slippage. File scratch test ascertains the surface hardness of irregular parts or very small areas thereof. In order to verify average conditions, it is desirable to have a series of such scratches produced and thus check the average conditions rather than minute spots.

Test files may be selected which are more convenient in size or design to suit special requirements. In many cases standardized dimensions, tooth size or length may be more suitable if standard test files or even standard files of available dimensions are heat treated to a hardness which will cover specific hardness ranges.

Electropolishing of Carbon Steels

Condensed from a Paper for the Electrochemical Society

Mechanical polishing of a metal specimen results in a film of distorted, or flowed, metal on the immediate surface. This does not represent the true structure of the metal, which is built of atoms which aggregate to form crystals. Laws that govern the behavior of metals under plastic flow might be formulated if these crystallites could be examined under the electron microscope.

Work has been done in the field of electrolytic polishing and anodic etching to eliminate this layer of distorted metals, to remove all solid phases of the metal at the same rate so as to obtain a plane surface, and to remove all scratch furrows.

The Baths Used

Both organic and inorganic baths are used. The organic are generally restricted to laboratory use. Inorganic baths are composed principally of sulphuric and phosphoric acids. Various mixtures have been studied. Sulphuric acid alone shortens the time for polishing and requires high current densities. Phosphoric acid alone polishes at lower current densities but requires a long time. Mixtures of these two produce varied results.

All theories of electropolishing so far

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advanced favor the formation of an insulating film over the surface of the anode. This probably exists in reality, but its composition will differ for each bath. If it does exist, the high points on the surface will protrude and bear the load of the current. Therefore current density will vary over the surface and rapid removal of ridges will result.

Mild irregular agitation is beneficial as it is not disturbing to the low areas. It removes the bubbles which would otherwise produce an undulating effect on the surface. It also minimizes pitting around surface inclusions in the metal.

Some Advantages

The advantages of anodic polishing of plain carbon steels are:

1. Specimens can be polished to a degree of perfection comparable to competent mechanical polishing.
2. They may be polished on all faces.
3. A better contrast is obtained between the constituents.
4. Non-metallic inclusions and flaws are more clearly defined.
5. Electropolished surfaces are much more brilliant.
6. Electropolishing takes only a few minutes.
7. The true structure of the metal is presented.

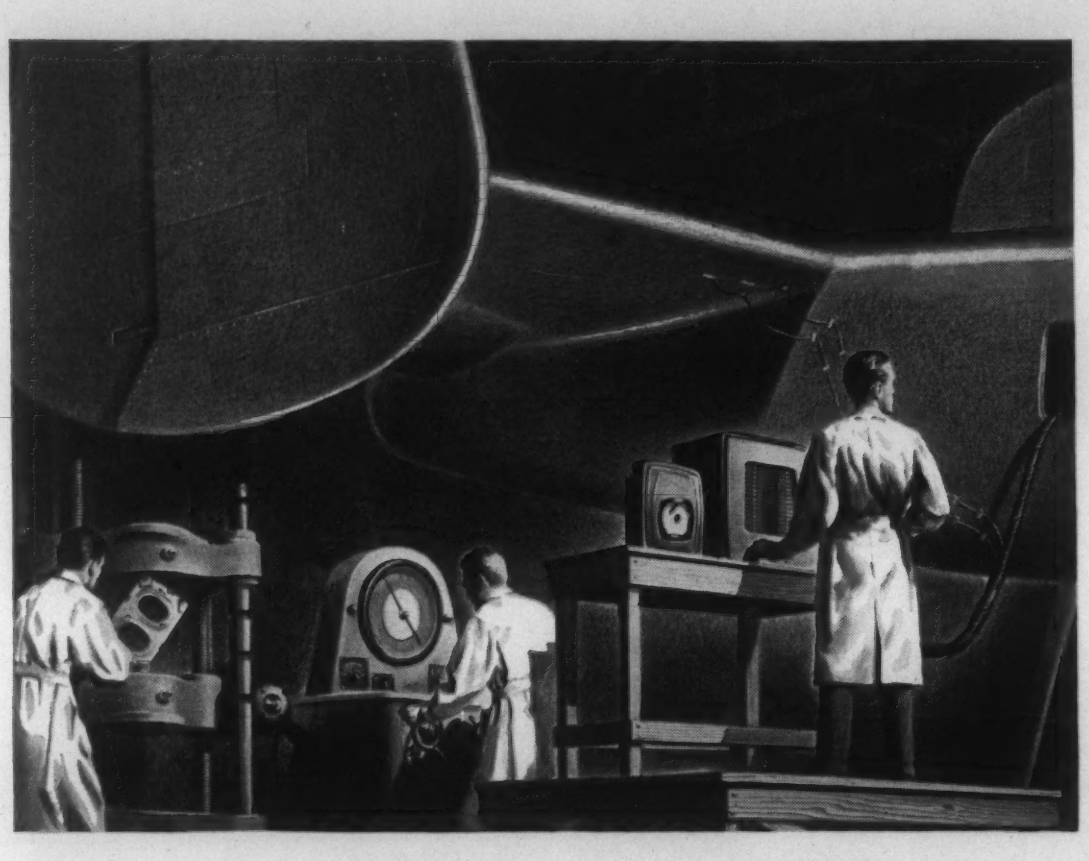
The anode holder must hold any size or shape of sample, must not be attacked by anodic action or the solution, must allow flow of current from contact to withdrawal, must permit ready removal of samples, and agitation of the solution.

The bath container must permit agitation of the solution, and have walls which conduct heat if a cooling bath is used.

The cathode area must be larger than that of the anode. The cathode must not react with the bath. Sheets of aluminum, low carbon steel or stainless steel are satisfactory.

The advantage of two-dimensional metallographic study cannot be over-stressed. Constituents unnoticed in one view show dominantly in the other.

—Robert L. Imboden and Robert S. Sibley, *Trans. Electrochem. Soc.*, Vol. 82, Preprint 82-18, 13 pages.



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For a complete listing of Southwark testing equipment write for Bulletin G-107 to Baldwin Southwark Division, The Baldwin Locomotive Works, Philadelphia; The Pelton Water Wheel Co., San Francisco.

Magnetic Powder Inspection for Sub-Surface Flaws

Condensed from an American Welding Society Paper

It was found that magnetic powder tests could be used for the detection of certain sub-surface defects in weldments and castings. Some defects other than those of a crack-like nature may be detected, but the patterns caused by them may be similar in appearance to those caused by defects of another nature, so that the method is not reliable for the positive identification of various types of deep-seated defects.

It was noted that sub-surface defects may be distinguished from surface defects by the appearance of the powder accumulation. Surface defects cause narrow, sharply-defined patterns, while sub-surface defects cause wider, more diffuse patterns, the width of the pattern being dependent upon the width and depth of the defect.

Detectability of defects is dependent upon their size, shape, and orientation, as well as upon their depth, and the thickness of section in which they are located. A defect may be detected farther below the surface in a thick section than in a thin section.

Owing to the number of factors that influence the results obtained from this method, it is not reliable for positive detection of all defects, even when limited to a definite depth below the surface. Rounded defects, such as porosity in welds and some gas cavities in castings are rather difficult, if not impossible, to detect.

One thousand amperes was found to be a practical limit to the amount of current used for magnetization. The danger of burning or over-heating the surface of the metal and the presence of appreciable amounts of remanent magnetism in some cases limit the use of the method. It is very difficult to standardize magnetic powder patterns for the purpose of inspection.

A procedure chosen as best suited for the purpose of detecting sub-surface defects is offered, in connection with which it should be noted that it is necessary to use more than ordinary care when searching for deep-seated defects, with regard to the application of the procedure as well as to the interpretation of results.

—C. W. Hastings, Paper, *Amer. Welding Soc.*, Oct. 1942 meeting.

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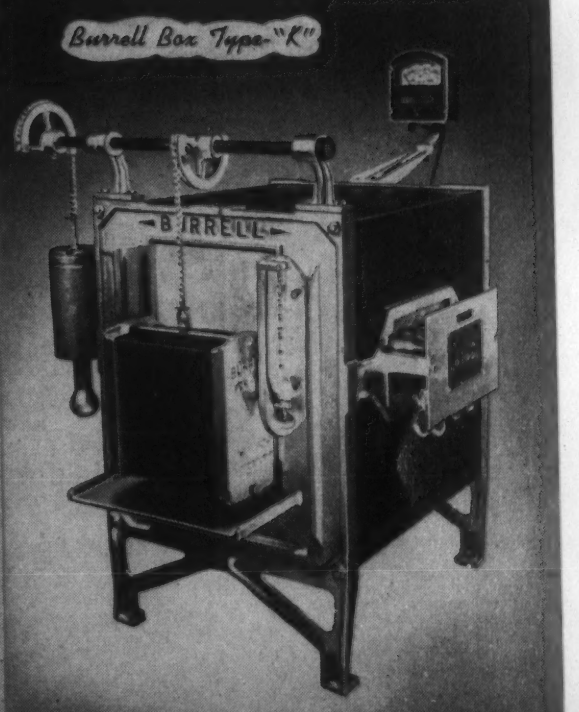

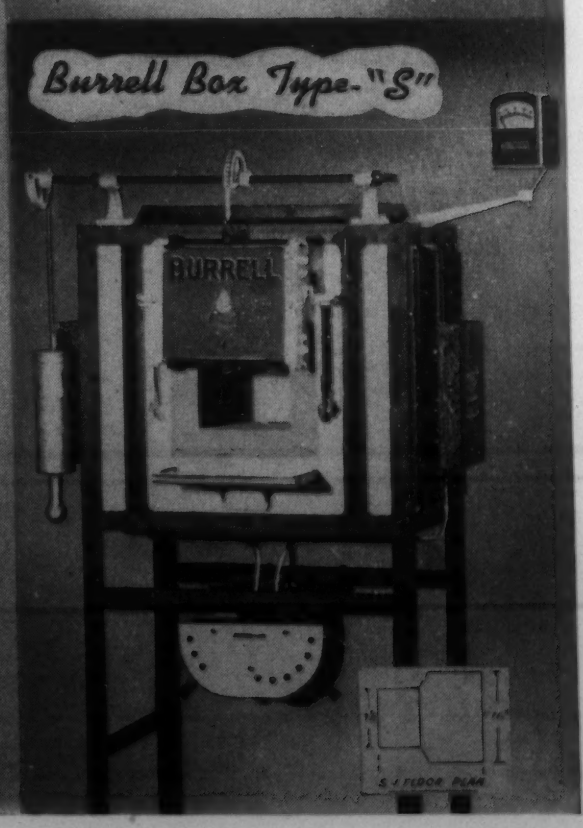

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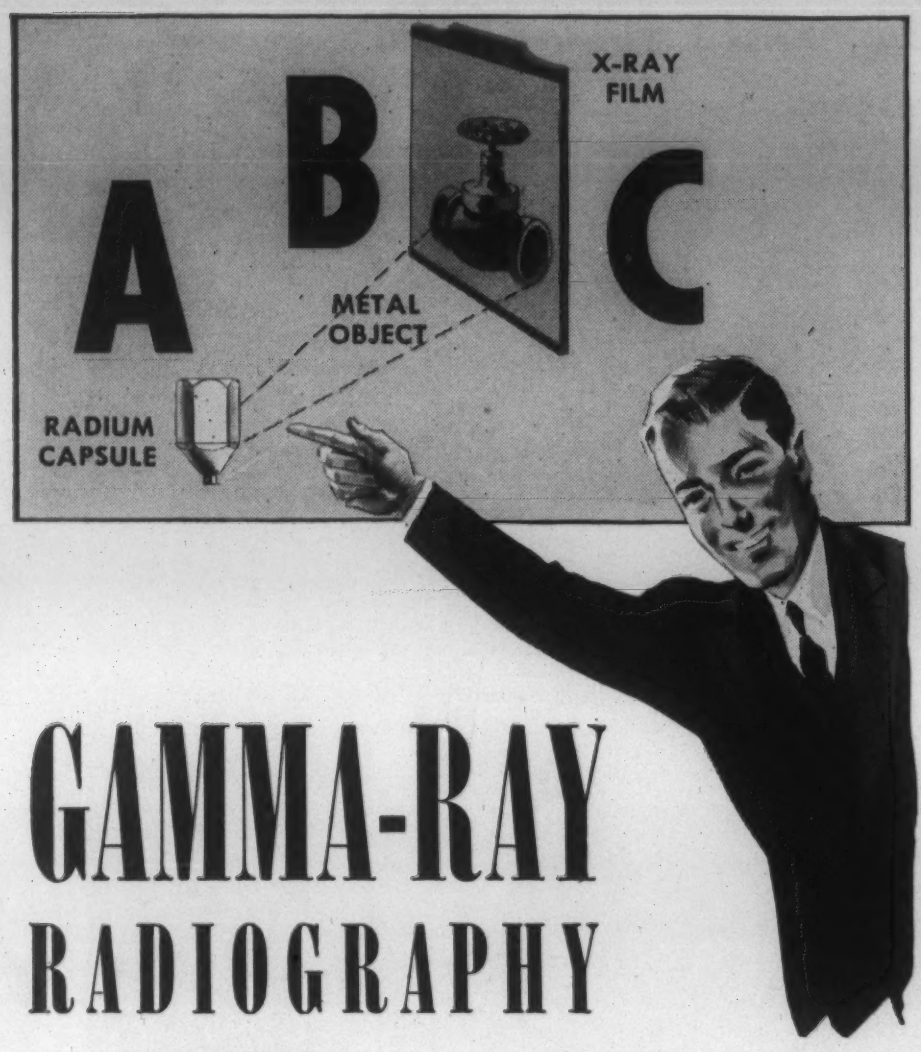

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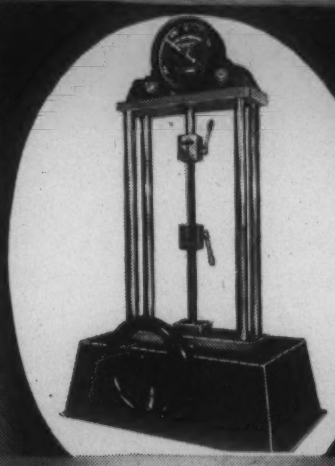

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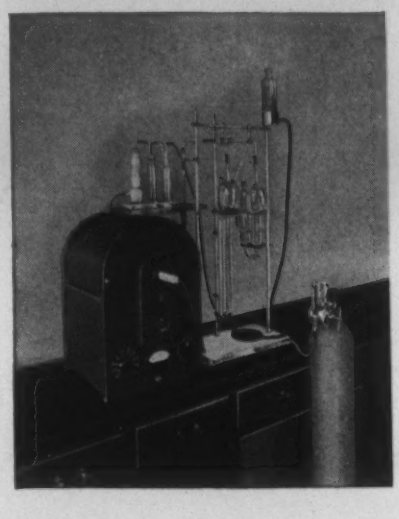

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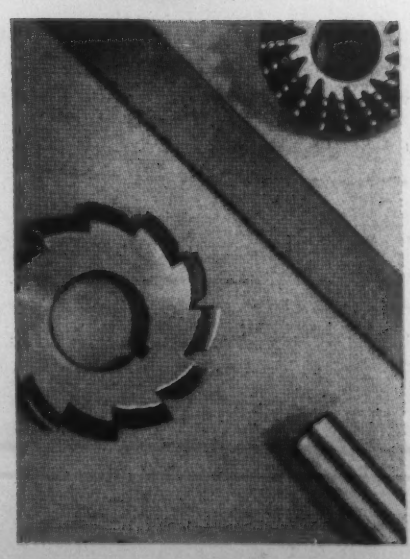

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FOR METALLURGICAL ENGINEERS

Alloys, Properties and Structure

STRUCTURE AND PROPERTIES OF ALLOYS. *By R. M. Brick and Arthur Phillips. Published by McGraw-Hill Book Co., Inc., New York, 1942. Cloth, 6¼ x 9¼ in., 227 pages. Price $2.50.*

This is an outgrowth of a course given to engineering students at Yale for the past 20 years, revamped a bit to meet the war production problem of up-grading people who have only a smattering of formal metallurgy, into a more intelligent understanding of the technology of metals.

Without attempting to cover metallurgy as a whole, it deals particularly with the correlation of phase diagrams and microstructure with the properties of alloys. It tries to link the metallographer more closely with the engineer.

One can tackle such a task by stating fundamental principles and generalities and drive the lessons home by citing pertinent examples, or he can start with specific cases of good and poor properties, of failures and of satisfactory performance, connect these with the structure and finally with the equilibrium diagrams, S curves, etc. using the case history method. The authors do a little of both, which makes the book a bit easier reading than if the first method had been wholly adhered to, and avoids using quite as much space as if the second had been used. Commercial ferrous and nonferrous metals and alloys are discussed, with special emphasis on steels.

It's a good job. If any criticism were to be made, it would be that the emphasis is a bit heavy on the post-mortem side and a bit light on the discussion of how to adjust processing methods so as to produce desirable structures and properties. As an example, modern discussion of heat-treatment would seem to require some consideration of controlled atmospheres. The authors have stuck closely to what, as they admit in the preface, is a "narrow field." Most readers will regret that they did confine themselves so closely, but will nevertheless be thankful for the clear and authoritative treatment of what they did cover.

—H. W. GILLETT

Mechanical Design Data

HANDBOOK OF MECHANICAL DESIGN. *By George F. Nordenholt, Joseph Kerr and John Sasso. Published by McGraw-Hill Book Co., Inc., New York, 1942. Cloth, 8¾ x 11 in., 277 pages. Price $4.00.*

This useful volume contains a wealth of tabular data to aid in the solution of mechanical design problems, taken mostly from material published in *Product Engineering*.

Most of the data are concerned with structural engineering or with "mechanisms" (latches, locks and fastenings; springs; power transmission elements and mechanisms; drives and controls). There are, however, some 38 pages on "materials" and 26 on "production methods," which give information needed by the design engineer trying to decide which material to use for a given part and what fabricating process to employ.

The chapter on materials is good as far as it goes, but appears to us somewhat superficial or "introductory." For an engineer with little familiarity with the broad differences among the various materials the chapter should be very useful indeed, but the practicing designer or materials engineer needs many more specific data on metals, alloys, metal-forms and non-metals than can be compressed into 38 pages.

This is a minor criticism, however, since the book is not intended to feature materials primarily, but only to cover them as part of the overall design problem. Very little of the material in the volume can be found in conventional handbooks.

The inclusion of an index — now omitted for some reason — would certainly increase the usefulness of the next edition.

—FRED P. PETERS

Other New Books

AIRCRAFT RIVETING FUNDAMENTALS. *By George E. Tabraham. Published by The Bruce Publishing Co., Milwaukee, 1942. Paper, 8¼ x 10¾ in., 31 pages. Price 50c.* This pamphlet discusses, among other fundamentals, various primary riveting "jobs" such as drilling off rivet heads, drilling exercises, blind riveting, driving rivets on a countersunk curved plate, subcountersinking, etc., together with explanatory sketches. There are also brief discussions on aircraft sheet stock, aircraft rivets and rivet information.

ELEMENTARY PHYSICAL CHEMISTRY. *By Merle Randall & Leona E. Young. Published by Randall and Sons, Berkeley, Calif., 1942. Cloth, 6 x 9 in., 455 pages. Price $4.50.* This is a textbook, designed not only for teaching but for home study. While home study of such a subject, particularly the first approach to it, is a tough job, the book is better fitted for such use than the average text book. Almost the only directly metallurgical information contained is the introduction to the phase-rule diagrams. If the metallurgist had been thought of in its writing, the iron-carbon diagram and some precipitation hardening system would have been included.

GLOSSARY OF METALLOGRAPHIC TERMS. *By J. Neill Greenwood. Published by Chemical Publishing Co., Inc., Brooklyn, N. Y., 1941. Cloth, 5¾ x 8¾ in., 80 pages. Price $2.00.* An evidently authoritative dictionary. Where a term has synonyms or more than one meaning, all are given. Copious cross-references are included. If a term ("age-hardening," for example) has such broad implications as to defy adequate condensed definition, the reader is referred to a literature reference for additional explanation.

AIRCRAFT HANDBOOK—FIFTH EDITION. *By Fred H. Colvin. Published by McGraw-Hill Book Co., Inc., New York, 1942. Fabrikoid, 6 x 8¾ in., 784 pages. Price $5.00.* Describes the most important aircraft engines and aircraft electrical systems from the maintenance viewpoint. A useful "service" manual.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS (Vol. 147, INSTITUTE OF METALS DIVISION). *Published by American Institute of Mining and Metallurgical Engineers, New York, 1942. Cloth, 6¼ x 9¼ in., 405 pages. Price $5.00.* Contains 32 papers on non-ferrous metals, including the Institute of Metals Division Lecture by W. R. Webster on Wrought Brass, presented before the Division at the February, 1942 meeting of the Institute.

METALLURGY. *By Carl G. Johnson. Published by American Technical Society, Chicago, 1942. Cloth, 5¾ x 8½ in., 262 pages. Price $2.50.* This is the second edition of a very useful elementary book on the fabricating and service behavior of metals and alloys. It costs more than the first edition, but it is some 110 pages longer and considerably better, many of the gaps having been filled. About the best short simple book on practical elementary metallurgy available.

ARC WELDING JOB TRAINING UNITS. *Published by American Technical Society, Chicago, 1942. Cardboard, 8½ x 11 in., 103 pages. Price $1.25.* This arc welding manual has been produced by the staff of the Dunwoody Industrial Training Institute of Minneapolis. The plan of training and the training material have been developed, treated and improved by not only the Dunwoody Institute, but also by the Smith Welding Corp. and the Commercial Gas Co., also of Minneapolis. The arc welding unit consists of 40 jobs with an information sheet and a sheet of check-up questions for the first 32 jobs. There are several pages of suggestions and helps on the use of the manual.

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The Navy needs every binocular it can get. If you have a Bausch & Lomb 6 x 30 or 7 x 50 binocular and will turn it over to the Navy for the duration, pack it carefully and ship to the Naval Observatory, Washington, D. C., or deliver to the nearest naval district headquarters. An identification tag bearing your name and address should be fastened securely to each instrument. Accepted binoculars will be acknowledged with a fee of one dollar and will be returned to you after the war if still in use.

The Navy is not authorized to accept gifts or free loans. Therefore, the binoculars are purchased for $1.00 and if they are available after the war they will be returned to the owner, in which case the $1.00 will constitute rental and appreciation charges. Commanding officers of naval vessels are requested to notify you of the ship aboard which your binoculars are in service.

They're in the Navy Now

SOMEWHERE on the high seas, with engines throbbing in the urgency of their mission, grim gray ships press forward in spite of the deadly perils of sea and sky.

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Binoculars are among the many optical instruments of war that Bausch & Lomb is producing and helping others to produce. Today, Bausch & Lomb is working a full twenty-four hours a day, but even with its vastly expanded production program there is not room enough, nor time enough, to turn out all of the binoculars the Navy needs.

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Manufacturers' Literature

YOURS FOR THE ASKING

1. Ferrous Metals

ALLOY IRONS

Molybdenum Iron and Steel. Climax Molybdenum Co. (1-76)

ALLOY STEELS

Titanium in Steel. Titanium Alloy Mfg. Co. This is a 113-page bound book, text-book style, technical enough for the advanced engineer and readable for the layman. Photos and tables supplement the text. (1-201)

Basic Open-Hearth Alloy Steel. Andrews Steel Co. (1-166)

Steel Composition Ranges. Babcock & Wilcox Company. (1-146)

Low Alloy Steel. Bethlehem Steel Co. (1-117)

High Strength Steel. Great Lakes Steel Corp. (1-2)

Molybdenum Wrought Steels. Molybdenum Corp. of America. (1-139)

Special Steels. A. R. Purdy Company. (1-194)

CARBON STEELS

Cold-Worked Steels. Crucible Steel Co. of America. (1-187)

Phosphorus in Steel. Monsanto Chemical Co., Phosphate Division. (1-107)

HIGH SPEED STEELS

Fast Machine Steels. Monarch Steel Co. (1-95)

STAINLESS STEELS

Special Steels. Allegheny Ludlum Steel Corp. (1-196)

Stainless Steel. Electro Metallurgical Co. (1-199)

Stainless Steels. Industrial Steels, Inc. (1-96)

Stainless Clad Steel. Ingersoll Steel & Disc Div., Borg Warner Corp. (1-104)

Stainless Steels. Rustless Iron & Steel Corp. (1-105)

TOOL AND DIE STEELS

Die Steel. Jessop Steel Co. Six pages are devoted to Truform oil hardening non-shrinkable steel. Information is compact and illustrations are used sparingly. (1-200)

Spark Testing Tool Steels. Carpenter Steel Co. (1-190)

IRON AND STEELS—GENERAL

Electrolytic and Sponge Iron Powder. Plastic Metals, Inc. (1-167)

Quality Machinery Steels. Horace T. Potts Co. (1-116)

2. Non-Ferrous Metals

COPPER AND ITS ALLOYS

Bronze Alloys. Ampco Metal, Inc. This is another of a series of one-page data sheets, No. 105, this being entitled "Experience Essential in Bronze Alloying." (2-196)

High Strength Bronze. American Manganese Bronze Co. (2-172)

Oxygen-free Copper. American Metal Co., Ltd. (2-145)

X-ray Tested Castings. Electro Alloys Co. (3-74)

Forgeable Tin-free Bearing Metal. Mueller Brass Co. (2-165)

Weights and Data for Brass and Bronze Products. Revere Copper & Brass, Inc. (2-170)

Special Copper Alloys. Seymour Manufacturing Co. (2-101)

LIGHT METALS

Surface Protection for Magnesium. American Magnesium Corp. This is a 15-page treatise under date of Sept. 1, 1942, "superseding all previous data." It is scientific and practical. (2-197)

Aircraft Aluminum Alloys. Reynolds Metal Co. This is a rather elegant little book of 30 pages of somewhat the text book method of treatment with tables and illustrations, one of which is beautifully colored. (2-195)

Aluminum in Aircraft. Aluminum Co. of America. (2-127)

Magnesium Alloys. Dow Chemical Co. (2-104)

Aluminum Alloy. National Bronze & Aluminum Foundry Co. (2-187)

LOW-MELTING METALS

Lead and Tin Products. Alpha Metal & Rolling Mills, Inc. (2-169)

Lead-Base Anti-Friction Alloy. Graphitized Alloys Corp. (2-183)

Babbitt Bearing Metals. Magnolia Metal Co. (2-191)

Lead. St. Joseph Lead Co. (2-188)

NOBLE METALS

Silver. Sherman & Company. (2-184)

SPECIAL METALS

Rare Metals, Alloys and Ores. Foote Mineral Co. (2-19)

3. Engineering Design

ALLOY CASTINGS

Stainless Steel Castings. Atlas Foundry Co., Stainless Steel Castings Div. A bulletin about applications and problems on corrosion-resistant castings, capable of resisting salt, caustic, acids, heat and abrasion, is available. (3-266)

Heat Resisting Steel Castings. Chicago Steel Foundry Co. "Pyrasteel" is described in 14 pages, with brief descriptions, tables and photos. (3-263)

Alloy and Stainless Steel Castings. Lebanon Steel Foundry. An 8-page booklet contains descriptive matter and helpful illustrations on alloy and stainless steel castings for use in a variety of industrial services. (3-265)

Alloy Castings. Sterling Alloys, Inc. This 4-page folder describes such castings in the heat and corrosion resisting class. Because of large type and several photos it is quickly read. (3-261)

Castings, Forgings and Industrial Equipment. American Brake Shoe & Foundry Co. (3-193)

Alloy Furnace Parts. American Manganese Steel Div., American Brake Shoe & Foundry Co. (3-216)

Stainless Castings. Cooper Alloy Foundry Co. (3-9)

Corrosive Handling Equipment. Duriron Company, Inc. (3-173)

Corrosion and Heat Resistant Castings. Michiana Products Corp. (3-91)

Cast Alloy Carburizing Boxes. Michigan Steel Casting Co. (3-165)

Special Alloy Castings. Ohio Steel Foundry Co. (3-81)

Cast Alloy Furnace Parts. Standard Alloy Co., Inc. (3-251)

CASTINGS—IRON, STEEL, NON-FERROUS, ETC.

Heavy-Duty Bronze Castings. Cramp Brass & Iron Foundries Div. (3-83)

Data on Brass and Bronze Castings. Hammond Brass Works. (3-194)

Meehanite Castings. Meehanite Research Institute. (3-248)

Centrifugal Castings. Shenango-Penn Mold Co. (3-250)

Vanadium in Cast Steels. Vanadium Corp. of America. (3-196)

FORGINGS

Drop Forgings. Drop Forging Association. (3-174)

METAL PARTS

Solderless Wiring Devices. Aircraft-Marine Products, Inc. (3-321)
Fittings for Weld-Type Construction. Bonney Forge & Tool Works. (3-199)
Special Metal Products. Callite Tungsten Corp. (3-128)
Permanent Magnets. Cinaudagraph Corporation. (3-260)
Thermostat Metals. General Plate Div., Metals & Controls Corp. (3-181)
Electrical Contacts. Gibson Electric Co. (3-76)
Welding Fittings. Girdler Corporation, Tube Turns Div. (3-241)
Bronze Bearings. Johnson Bronze Co. (3-224)
Sheet Metal Parts. Kirk & Blum Manufacturing Co. (3-238)
Wear Resistant Precious Metal Parts. Permo Products Corp. (3-65)
Sintered Metal Friction Materials. S. K. Wellman Company. (3-118)

NON-METALLICS

Bakelite. Bakelite Corporation. "Why Not Give it a Plastic Backbone?" is the lead article in a 24-page magazine. Several feature articles are contained therein, another being on "Printing with Plastics." (3-262)
Corrosion-Resistant Non-Metallic Material. U. S. Stoneware Company. Complete engineering data on Tygon, a synthetic rubber-like material possessing high corrosion resistance, and available in various shapes and forms, are presented in an attractive 16-page bulletin. (3-264)
Gaskets and Sealing Materials. Armstrong Cork Products Co. (3-255)
Plastics for Industry. Catalin Corporation. (3-232)
Non-Metallic Materials. Continental Diamond Fibre Co. (3-129)
Plastics. Creative Plastics Corp. (3-253)
Plastics. Durez Plastics & Chemicals, Inc. (3-235)
Plastic Data Book. Formica Insulation Co. (3-210)
Vibration Problems. B. F. Goodrich Rubber Co. (3-135)
Plastic Tubing and Fittings. Elmer E. Mills Corp. (3-247)
Plastics in the Emergency. Monsanto Chemical Co., Plastics Div. (3-96)

POWDER METALLURGY

(See also Sec. 1—Irons and Steels, General; Sec. 2—Special Metals; Sec. 3—Metal Parts; and Sec. 8—Metal Powder Processing.)

Sintered Iron Parts. Bound Brook Oil-Less Bearing Co. (3-252)
Powder Metallurgy Products. Powder Metallurgy, Inc. (3-89)

TUBING

Tubing for Shot Guns. Summerill Tubing Co. (3-228)
Fine Small Tubing. Superior Tube Co. (3-133)

OTHER METAL FORMS

"Pre-Finished" Plated Metals. American Nickeloid Co. (3-218)
Wire Conveyor Belts. Cambridge Wire Cloth Co. (3-141)
Structure Design and Assembly. Dry-Zero Corp., Lindsay Structure Div. (3-184)

Metals and Alloys, 330 West 42nd St., New York, N. Y.

I should like a copy of each piece of Manufacturers' Literature listed

We request students to send their inquiries direct to the manufacturers

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Design for Spinning. Milwaukee Metal Spinning Co. (3-124)

4. Melting • Refining • Casting

ALLOYING AGENTS

Recuperators for the Steel Industry. Fitch Recuperator Co. (4-121)
Lithium Copper. P. R. Mallory & Co., Inc. (4-55)
Fluxes. Niagara Falls Smelting & Refining Corp. (4-124)
Graphite Briquettes. U. S. Graphite Co. (4-112)

AUXILIARIES

Zirconium and Titanium Products. Titanium Alloy Mfg. Co. Here is a handy and ingenious sliding chart, revealing various combinations, and quantities thereof, for types of sand mixes and facing and flour mixes. (4-125)
Centrifugal Casting and Equipment. Centrifugal Casting Machine Co. (4-83)
Reclaiming Scrap Metal. Dreisbach Engineering Corp. (4-63)
Molding Sand Binder. Hercules Powder Co. (4-103)
Mold and Core Wash. Refractory Mica Products, Inc. (4-107)
Core Oils. Swan-Finch Oil Corp. (4-118)
Universal Cut-Off Machine. Tabor Manufacturing Co. (4-109)
Special Crucibles. Western Gold & Platinum Works. (4-122)

REFINING AGENTS

Refining Agent for Copper Alloy Castings. Foundry Services, Inc. (4-93)

MELTING FURNACES AND PARTS

High Frequency Furnaces. Ajax Electrothermic Corp. (4-60)
Laboratory Crucible Furnace. Campbell-Hausfeld Company. (4-105)
Cutting Crucible Costs. Crucible Manufacturers' Assn. (4-36)

In this Manufacturers' Literature INDEX, new bulletins are given complete reviews, and previously described older bulletins are merely listed in their proper places.

Rocking Electric Furnaces. Detroit Electric Furnace Div. (4-52)
Crucible for Non-Ferrous Melting. Electro Refractories & Alloys Corp. (4-96)
Foundry Equipment. Fisher Furnace Corp. (4-69)
Die Casting Machines. Lester-Phoenix, Inc. (4-117)
Regenerative Furnace Control. Morgan Construction Co. (4-102)
Electric Melting Furnaces, Top Charging. Swindell-Dressler Corporation. (4-71)

RAW MATERIALS

Silvery Pig Iron. Jackson Iron and Steel Co. "The Story of Silvery Pig Iron," 26 pages, is largely straight text and highly informative, written by Bradley H. Booth, metallurgist. (4-126)

5. Heating • Heat Treatment

ATMOSPHERES AND GENERATORS

Control of Furnace Atmosphere. C. I. Hayes, Incorporated. (5-33)
Gas Air Pre-Mixer. C. M. Kemp Manufacturing Co. (5-167)

AUXILIARIES

Quenching Oil Strainers. Bell & Gossett Company. B & G "Kleen-Well" oil strainers for quenching-oil cooling systems are the subject of a 6-page descriptive bulletin. (5-357)
Pressed Steel Pots. Eclipse Fuel Engineering Co. The product for lead, salt, cyanide, oil tempering and metal melting is described in a 4-page leaflet, with diagrams and tables. (5-352)
Temperature Signalling Medium. Tempil Corporation. Tempilaq, a liquid that can be painted on heated surfaces for the purpose of indicating stated temperatures, is briefly described in a leaflet. (5-360)
High Temperature Heating Elements. Carborundum Company, Globar Division. (5-122)
Heat Treatment Calculator for Alloy Steel. Peter A. Frasse & Co., Inc. (5-287)
Sub-Zero Machines for the Metal Industries. Kold-Hold Manufacturing Co. (5-349)

Heat Exchanger for Metallurgical Operations. Niagara Blower Co. (5-293)

Carburizing Boxes. Pressed Steel Company. (5-245)

Butterfly Valves. R-S Products Corporation. (5-348)

Sub-Zero Chest. Revco, Incorporated. (5-350)

Furnace Door Hoists. Fred J. Ryan Company. (5-333)

Quenching Oil Coolers. Whitlock Manufacturing Co. (5-318)

BATHS AND COMPOUNDS

Heat Treatment of Shells. E. F. Houghton & Company. Highly useful information on shell steel and its heat treatment and quenching is packed into a 16-page technical bulletin, replete with illustrations. (5-361)

Carburization Check. Park Chemical Co. A 4-page leaflet describes "No-Carb", a liquid paint for prevention of carburization or decarburization. Micrographs help get over the message. (5-351)

Balanced Carburizing Baths. American Cyanamid & Chemical Corp. (5-135)

BLOWERS AND COMPRESSORS

Centrifugal Blowers. Allen Billmyre Corp (5-343)

Steam-Driven Compressors. Ingersoll-Rand Company. (5-215)

Blowers, Gas Boosters, Etc. Roots-Connersville Blower Corp. (5-192)

Turbo Compressors. Spencer Turbine Co. (5-335)

BURNERS

Gas Appliances. Johnson Gas Appliance Co. (5-286)

ELECTRICAL HARDENING AND HEATING

Induction Heating Equipment. Lepel High Frequency Laboratories, Inc. An attractive color treatment sets off a 20-page booklet on high frequency heating for hardening, annealing, brazing, soldering and melting. (5-355)

Induction Hardening. Ohio Crankshaft Co Here are 16 pages of valuable facts, presented artistically. Not too technical for the average reader. (5-356)

Electric Forging Heaters. American Car & Foundry Co. (5-23)

Induction Heating Data Sheets. Induction Heating Corp. (5-299)

FURNACES

Tool Room Oven Furnace. American Gas Furnace Co. An improved tool room oven furnace for clean-hardening and a high-speed steel hardening furnace, both gas-fired, are concisely described in this loose-leaf data sheet. (5-362)

Electric Furnaces. Cooley Electric Mfg. Co. These furnaces for industrial and laboratory uses — "Do your own heat-treating of small parts" — are described in a 4-page folder, amply illustrated. (5-364)

Industrial Furnaces. Dempsey Industrial Furnace Corp. Recirculating furnaces for annealing, stress relieving, heat-treating, heating for rolling, etc. are described in a 4-page leaflet, with diagrams and photos. (5-363)

Heat Treating Bombs and Shells. Surface Combustion Div., General Properties Co. Valuable hints for war-production engineering are contained in a 4-page bulletin on furnaces for forging, nosing and heat treating bombs, shells and cartridge cases. (5-359)

Electric Heat Treating Furnaces. Harold E. Trent Company. Commercial heat treating furnaces of salt bath, air draw, box type, or conveyor type are briefly described and illustrated in a 4-page bulletin. The special Fold-Form heating elements are featured. (5-358)

Electric Salt Bath Furnace. Ajax Electric Co., Inc. (5-327)

Electric Pot Furnaces. American Electric Furnace Co. (5-97)

Ingot Soaking Pits. Amsler-Morton Company, Inc. (5-81)

Blowerless Furnaces. Baker & Company, Inc. (5-168)

High-Speed Steel Furnace. Bennett Insured Steel Treating Co. (5-310)

Industrial Furnaces. Chicago Flexible Shaft Co. (5-159)

Heat Treating Furnaces. Drever Company. (5-258)

Chain Belt Conveyor Furnaces. Electric Furnace Co. (5-166)

Rotary Forging Furnaces. George J. Hagan Co. (5-265)

Heat Treating and Laboratory Furnaces. K. H. Huppert. (5-303)

Forced Convection Heating. Lindberg Engineering Co. (5-324)

Principles of New Atmosphere Furnaces. Lithium Corporation. (5-336)

Continuous Pusher-Type Roller Furnace. Mahr Manufacturing Co. (5-289)
Forced Convection Tempering Furnaces. Morrison Engineering Corp. (5-308)
Gas-Fired Tool Hardening Furnace. National Gas Furnace Co. (5-234)
Electric and Fuel Car-Type Furnaces. W. S. Rockwell Company. (5-298)
Gas-Fired Oven Furnaces. Rolnick Testing & Manufacturing Co. (5-175)
Heat Treating Furnaces. Salem Engineering Co. (5-341)
Bright Annealing Metal Strip. Sargeant & Wilbur. (5-200)
Clean Hardening for High Speed Tools. Sentry Company. (5-202)
Electric Salt Bath Furnaces. Upton Electric Furnace Div., Commerce Pattern Foundry & Machine Co. (5-295)
Heat Treating Furnaces. Vulcan Corporation. (5-243)

OVENS

Baking and Drying Ovens. Despatch Oven Co. Ovens for baking and drying synthetic enamels, lacquers, varnishes, paints, etc. of a wide variety of designs are described and illustrated in a useful 12-page booklet. (5-363)
Industrial Ovens. J. O. Ross Engineering Corp. Elaborate photographs feature this 19-page bulletin, No. 130, which deals in ovens and accessories for several purposes. (5-354)

PROCESSES

Heat Treating High Speed Tool Steels. Tuff-Hard Corporation. (5-280)

6. Refractories · Insulation

Castable Refractories. Laclede-Christy Clay Products Co. This interesting 4-page bulletin is devoted to Hearthmix, a self-hardening castable refractory material for use up to 2700 deg. F. (6-106)
Plastic Monolithic Firebrick. Mexico Refractories Co. This colorful bulletin contains 28 pages of descriptive and practical information on Mono-Fibrik plastic firebrick and its installation in all types of furnaces. (6-105)
Silica Tubing and Rod. Thermal Syndicate, Ltd. Vitreous silica drawn tubing and rod, opaque, translucent or transparent are described in a 4-page folder, the major portion being devoted to price tables. (6-103)
Refractory Insulating Concrete. Atlas Lumnite Cement Co. (6-66)
Heat Insulation. Baldwin-Hill Company. (6-99)
Dolomite for Electric Furnaces. Basic Refractories, Inc. (6-88)
Plastic Super-Cement. Botfield Refractories Co. (6-94)
Refractory Coating Material. Brickseal Refractory Co. (6-67)
Heavy Duty Refractories. Carborundum Company, Refractory Division. (6-45)
Flux Resistant Refractory. Corhart Refractories Co. (6-95)
Refractories Maintenance Coating. A. P. Green Firebrick Co. (6-70)
Refractory Fire Brick. Harbison-Walker Refractories Co. (6-44)
Insulating Brick. Illinois Clay Products Co. (6-100)
Mineral Wool Insulation. Industrial Mineral Wool Institute. (6-96)
Medium-Duty Fire Brick. Ironton Fire Brick Co. (6-46)
High Temperature Insulation Blocks. Johns-Manville Corporation. (6-73)
Super-Refractories Products. Mullite Refractories Co. (6-775)
Super Refractories. Charles Taylor Sons Co. (6-16)
Castable Refractory. Walsh Refractories Corp. (6-89)

7. Welding

BRAZING AND SOLDERING

Low-Temperature Brazing of Bombs. Handy & Harman. A pictorial story, together with adequate descriptive text, of the low-temperature silver alloy brazing by induction of bomb flanges is presented in a 2-page bulletin. (7-169)
Substitute Tin Solders. American Smelting & Refining Co., Federated Metals Div. (7-149)
Indium Solders. Indium Corporation of America. (7-155)
Soldering, Brazing Flux. Special Chemicals Corp. (7-67)
Electric Furnace Brazing. Westinghouse Electric & Manufacturing Co. (7-112)

ELECTRIC ARC WELDING

A.c/d.c. Arc Welders. Dearborn Stove Co., Dearborn Welder Div. A single sheet briefly describes box-shaped arc welders, combining a.c. and d.c. in one unit (7-165)

Heating ordnance materials requires *precision*

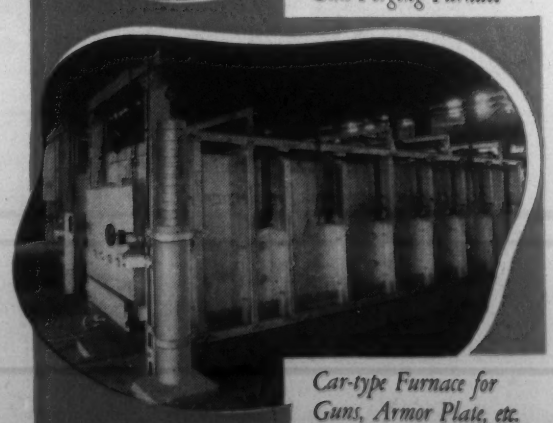
Rotary Hearth Furnace for heating all sizes of billets for shell forgings

AMCO FURNACES

..have successfully met this vital need

The heating of shell and gun forgings calls for *uniform temperatures!* AMCO FURNACES are modern versions of *designs proved in actual service*...the acid test for such important operations. Write for details on the complete line of AMCO Furnaces, one of which will no doubt serve your particular purpose!

Gun Forging Furnace



Car-type Furnace for Guns, Armor Plate, etc.

The AMSLER-MORTON COMPANY
FULTON BUILDING • PITTSBURGH, PA.

Arc Welding Accessories. General Electric Company. A complete line of arc welding accessories, such as goggles, shields, protectors, clamps, etc. is presented in a 32-page catalog. (7-168)

Changing Press Design for Welding. Lincoln Electric Company. Comparative design and cost information on the manufacture of a press by a former method and by welding are interestingly presented in a 4-page bulletin. (7-170)

Arc-welding Electrodes. McKay Co. Here is a handy 28-page reference book, with tabular data and photos. (7-164)

Reclaiming High Speed Tools. Welding Equipment & Supply Co. Welding of such steel tools to keep used ones in service is described in 28 pages and is timely in this era of conservation. Several "before and after" photos are given. (7-166)

Conserving Electrodes. Air Reduction Co. (7-145)

Welding Equipment. American Agile Corp. (7-146)

Electrode Color Chart. Arcos Corporation. (7-78)

Conservation by Hard-Facing. Coast Metals, Inc. (7-107)

Hard-Facing Alloys. Dymonhard Corp. of America. (7-136)

Alternating Current Welding and Its Cost. General Electric Co. (7-122)

Austenitic Stainless Steel Electrodes. Harnischfeger Corporation. (7-110)

Arc Welding Electrodes. Metal & Thermit Corp. (7-47)

High Tensile Welding Wire. Page Steel & Wire Div., American Chain & Cable Co. (7-12)

Welding Stainless Steel. Republic Steel Corp. (7-143)

A. C. Welders. Westinghouse Electric & Manufacturing Co. (7-156)

FLAME-PROCESSING

Oxyacetylene Welding and Cutting. Linde Air Products Co. (7-75)

Hard Surfacing Welding Rod. Wall-Colmonoy Corp. (7-127)

GAS WELDING

Low-Temperature Welding. Eutectic Welding Alloys, Incorporated. The use of Castolin eutectic welding alloys for fast-production welding and salvaging of defective and broken parts and tools is effectively described in a practical 4-page folder. (7-167)

Bronze-Welding Alloys. Bridgeport Brass Co. (7-79)

Gas Welding Tips. National Cylinder Gas Co. (7-85)

RESISTANCE WELDING

Welders for Aluminum. Progressive Welder Co. A 4-page bulletin, No. 101, describes the company's new line of "Revers-O-Charge" welding equipment for aluminum alloys, including the built-in refrigerating unit for electrode refrigeration. (7-162)

Spot and Seam Welders. Sciaky Brothers. This modern-type booklet of 16 pages is a very attractive job, complete with text, photos, blue prints, charts, and micrographs. (7-163)

Seam Welders. Taylor-Winfield Corporation. (7-99)

Electronic Welding Timer. Westinghouse Electric & Manufacturing Co. (7-142)

SUPPLIES

Flux. American Products Corp. (7-158)

Metal Cutting and Welding Equipment. Victor Equipment Co. (7-139)

8. Metal-Working

FORMING

Hydraulic Presses. Farrel-Birmingham Co., Inc. Here is a well-balanced presentation through word description, photos, diagrams and captions. Primarily presses for metal forming are dealt with, as well as presses for plastics and other materials, in 14 pages. (8-187)

Fabrication of Steel. L. O. Koven & Bro., Inc. "Koven Men and Machines for War Work" is the subject of an attractive 16-page booklet, depicting the company's varied fabrication facilities. (8-189)

Tube Benders. Pines Engineering Co., Inc., Hydraulic tube benders for tubes, bars or shapes and some of their constructional features are presented in leaflet form. (8-201)

Colloidal Graphite. Acheson Colloids Corp. (8-147)

Inclinable Presses. E. W. Bliss Company. (8-177)

Die Matrix Alloys. Cerro de Pasco Copper Corp. (8-106)

WOULD HAVE A GOOD LAUGH

The Indian and the buffalo have been taken off the good old "nickel" . . . and now they say the nickel is going too.

Taking nickel out of the five-cent piece has emphasized the importance of conserving this critical metal.

You can help by using Durimet instead of alloys having a much greater nickel content. In most cases, Durimet (Fe; Cr 19; Ni 22; C 0.07 max.; Mo 3.5; Cu 1.) will give perfect satisfaction under conditions where you have been using alloys often having up to 2½ times as much nickel.

Likewise, many of the processes where Durimet has been used in the past can be handled with alloys of lower nickel content until such time as increased supplies of this metal make it again universally available. For such applications we recommend Durco Stainless Steels of the so-called 18/8 group.

The Duriron Company was first in America to manufacture corrosion-resistant alloys and equipment exclusively. If there are acid-handling problems in your processes, you will find it worth while to get the benefit of our specialized experience.

Stamping Machine. Chambersburg Engineering Co. (8-99)
Assembling Presses. Denison Engineering Co. (8-120)
Straightening and Other Presses. A. B. Farquhar Co., Ltd. (8-75)
Hydraulic Press. Hydraulic Press Manufacturing Co. (8-140)
Fabricating Nickel Alloy Piping. International Nickel Co., Inc. (8-67)

FORGING

Shell-Making Machinery. Hydropress, Inc. (8-185)
Forging Hammers. Lobdell Car Wheel Co., Nazel Hammer Div. (8-130)

MACHINING

Tools for Hardened Steel. Black Drill Co. Here is a useful 22-page manual, packing in a wide variety of practical facts, augmented by tables, photos and diagrams. (8-191)

Standard Carbide Tools. Carboloy Company, Inc. This is a 30-page catalog, including prices and specifications of a large number of "standard design" tools not carried in stock. (8-195)

Better Broaching. Colonial Broach Company. A 24-page booklet contains articles on practical broaching methods and on increasing the life of broaches by correct sharpening. (8-198)

Fast Fan Milling. Firth-Sterling Steel Company. A 10-page factual engineering bulletin discusses "Hyper-Milling" for high-speed milling of steels, including cast armor and heat treated alloy steels. (8-196)

Tools. McKenna Metals Co. This 40-page catalog, No. 43, is sectionalized and divided into three sections: (1) standard tools, (2) typical non-standard tools, and (3) general information. (8-190)

Castor Oil Jelly Lubricant. National Graphite Co., Inc. The operating possibilities and advantages of Konag, a water-soluble castor oil lubricating jelly, as a coolant in automatic screw machine cutting are summarized in a leaflet. (8-200)

Grinding. Norton Company. "What's *Your* Grinding Problem?" titles a 27-page booklet, handy for the pocket and divided into ten chapters. Tables indicate what kind of wheel is suitable for each specific job. (8-188)

Cutting Oil Filter. Sparkler Mfg. Co. A single page treats of the Sparkler horizontal plate filter, with one photo. (8-193)

Metal Saws. Wells Manufacturing Corp. A 4-page leaflet gives photos and tables on specifications for saws to cut metals. (8-194)
Speed-and-Feed Calculator. Cincinnati Milling Machine Co. (8-142)
Cutting Oils. Cities Service Oil Co. (8-19)
Contour Sawing Machine. Continental Machines, Inc. (8-182)
Oil Filters. Cuno Engineering Corp. (8-108)
Cutting Oil. Gulf Oil Corp. (8-141)
Grinding Wheel Dressing. Koebel Diamond Tool Co. (8-76)
Reclamation System. National Conveyor Co. (8-169)
Belt Grinding. Porter-Cable Machine Co. (8-152)
Cutting Oils and Industrial Lubricants. D. A. Stuart Oil Co. (8-91)
Metal-Working Oils. Sun Oil Company. (8-148)
Filters for Lubricants. U. S. Hoffman Machinery Corp. Filtration Div. (8-125)
Lubricants. Wayne-Chemical Products Co. (8-174)

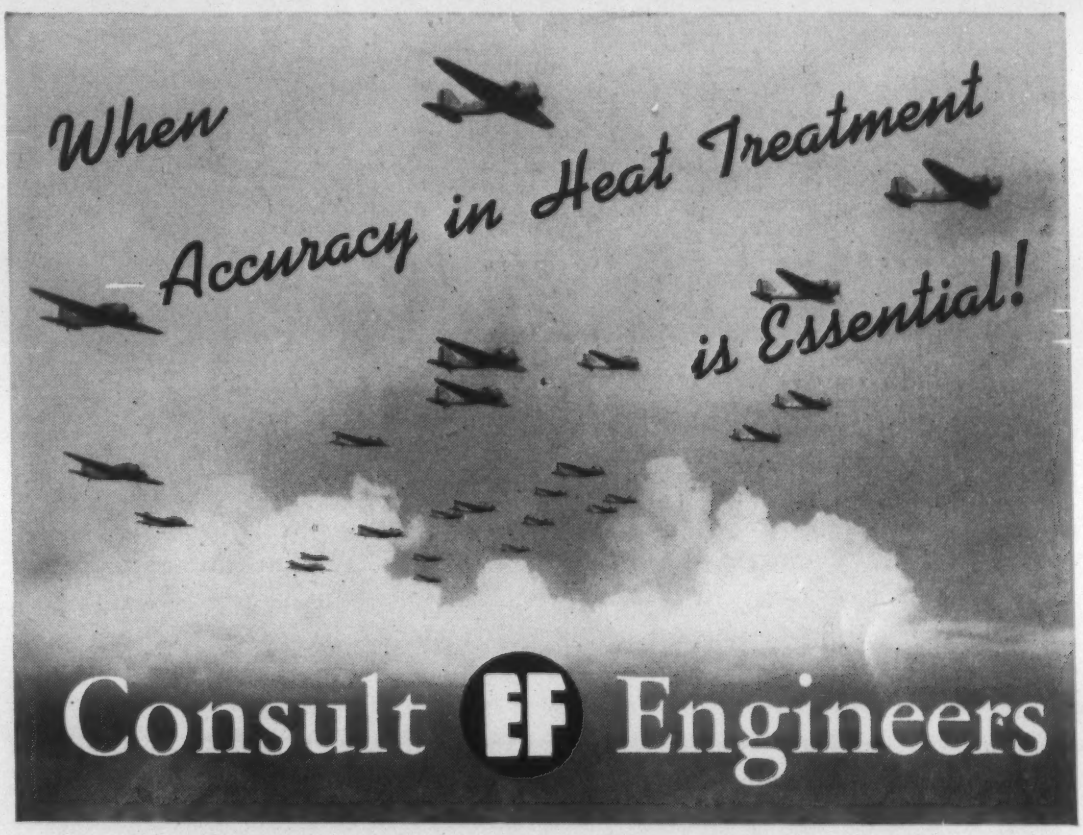
ROLLING

Steel Mill Roller Bearings. SKF Industries, Incorporated. A comprehensive, 90-page engineering reference volume gives formulas, designs, data tabulations and illustrations of roller bearing systems for steel mill applications. (8-197)
Turks Heads. Standard Machinery Co. This is an attractive 7-page bulletin, with perforated edge, describing Turks heads (adjustable draw plates for rolling square wire) used in the wire industry. (8-192)
Bending Rolls. Buffalo Forge Co. (8-74)
Rolling Mills, Screw Presses, Etc. McWilliams Manufacturing Co., Inc. (8-156)

METAL POWDER PROCESSING

Presses for Powdered Metals. Kux Machine Co. (8-62)
Batch Mixers. Lancaster Iron Works, Inc. (8-129)
Powder Mixing Machines. National Engineering Co. (8-92)

Please Use the Coupon on Page 1179



WHILE uniformity is desirable in any heat treating operation, accuracy is vitally important and an absolute necessity in the aircraft industry.

That's one reason why EF furnaces are used in so many plants manufacturing aircraft engines and aircraft engine parts.

The illustration below shows part of one such installation. These EF nitriding furnaces are producing the uniformly hard, wear-resisting surfaces required on aircraft engine cylinders.

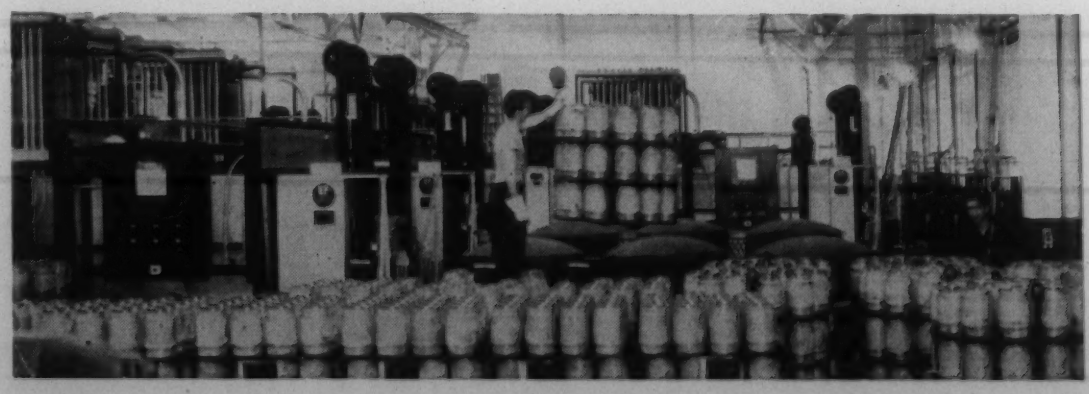
Designed for mass production, the furnaces are mounted on rails, in rows and in such a manner as to permit practically continuous operation. We build them in various sizes and types.

Recent EF installations include production furnaces for heat treating shell forgings, cartridge cases, tank armor castings, bomb and gun parts, machine gun cartridge clips, aircraft and aircraft engine parts, aluminum and magnesium castings, wire and wire products, bolts, springs and many other essential products.

Submit your production furnace problems to EF engineers. We build furnaces for annealing, hardening, forging, copper brazing, nitriding, normalizing, billet heating, and for every other heating or heat treating process.

The Electric Furnace Co.
Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces—For Any Process, Product or Production



Metal-Powder Mixers. Patterson Foundry & Machine Co. (8-114)
Compressing Machines for Metal Powders. F. J. Stokes Machine Co. (8-119)

9. Cleaning · Finishing

CLEANING

Metal-Cleaning Machines. Detroit Rex Products Co. This attractive and well-illustrated 24-page publication presents text descriptions and easy-to-read diagrams of Detrex metal parts washers. (9-217)

Processing Carriers. Rolock, Inc. Industrial baskets, crates, trays and fixtures are portrayed in this 4-page booklet, with plenty of illustrations. (9-214)
Metal Cleaning. Solventol Chemical Products, Inc. This 4-page leaflet describes a "new science of metal surface conditioning," with of course a war production slant to it. (9-216)
Handling Baskets. Union Steel Products Co. This 4-page folder depicts the wide uses of such wire and mesh baskets for heat-treating, washing, dipping, degreasing and handling and storing. (9-213)
Cleaning Machines. Alvey-Ferguson Company. (9-119)

Use of LUMNITE for Refractory Concrete Limited to Essential War Needs

THE distribution of LUMNITE is now under definite restriction in order to aid the War Production Program. Since November 1, careful control over shipments has been aimed at placing LUMNITE for essential war uses only.

Our customers and friends will understand the important reason for this. High-grade bauxite ore is urgently required for the production of metallic aluminum. It is also the principal raw material used in making the LUMNITE which is essential for Refractory and Insulating Concrete.

So that bauxite can be conserved and LUMNITE in sufficient quantities can be supplied for war needs, every pound of LUMNITE must work harder. We ask the patriotic cooperation of every customer in helping to distribute LUMNITE where it will do the most good in winning the War.

LUMNITE is held available for . . .

1. **Refractory and Insulating Concrete, or structural concrete exposed to high temperatures in plants engaged in war work.**
2. **Linings or coatings for protection of steel or other critical war materials against heat.**
3. **Other purposes when use of other available material will result in loss or delay of essential war production.**

Each specific order, however, will be considered and approved separately on the basis of need and on actual purpose of use in your plant or your product.

In line with this restricted sale, we offer the help of our Representatives in making most efficient use of LUMNITE. If you have any questions regarding the availability of LUMNITE, drop a line to the address below.

THE ATLAS LUMNITE CEMENT COMPANY
[United States Steel Corporation Subsidiary]
Chrysler Building, New York City

Blast Cleaning Equipment. American Foundry Equipment Co. (9-210)
Metal Descaling. Bullard-Dunn Div., Bullard Company. (9-205)
Spray Nozzles. Chain Belt Co. (9-194)
Metal Parts Cleaning. Colt's Patent Fire Arms Mfg. Co. (9-173)
Cold Degreasing. Curran Corporation. (9-150)
Dust Collecting Equipment. Industrial Sheet Metal Works. (9-184)
Pre-Cleaning for Plating. Macdermid, Inc. (9-110)
Copper Cleaner. Nielco Laboratories. (9-204)
Cleaning in the Aviation Industry. Oakite Products, Inc. (9-192)
Foundry Cleaning Equipment. Pangborn Corporation. (9-177)
Heavy Duty Cleaning of Ferrous Metals. Pennsylvania Salt Manufacturing Co. (9-129)
Light Steel Cleaning. Philadelphia Quartz Co. (9-195)
Oil Absorbents and Cleaners. Trojan Products & Manufacturing Co. (9-207)
Cleaning Compounds. Turco Products, Inc. (9-153)
Abrasive Cleaning. Vapor Blast Manufacturing Co. (9-166)

CHEMICAL TREATMENTS

Rustproofing. Parker Rust Proof Co. Here are 8 pages in a magazine-type publication, presenting various war applications of the Parkerizing process. (9-215)
Oxide Coating on Metals. Alrose Chemical Co. (9-167)
Black Steel Finish. Heatbath Corporation. (9-185)
Rustproofing. International Rustproof Corp. (9-120)
Chemicals for Protecting and Coloring Metal Surfaces. Mitchell-Bradford Chemical Co. (9-152)

ELECTROPLATING

Filter Equipment. Alsop Engineering Corp. (9-169)
Selenium Rectifiers. Benwood Linze Co. (9-209)
Industrial Chromium Plating. Chromium Corp. of America. (9-181)
Plating Chemicals and Processes. E. I. du Pont de Nemours & Co., Inc., Electroplating Div. (9-82)
Plating Rectifier. W. Green Electric Co., Inc. (9-158)
Cleaning and Plating Equipment. Udylite Company. (9-203)
Salvage by Hard Chromium Plating. United Chromium, Inc. (9-180)

METALLIC COATINGS (Non-electrolytic)

The Metallizing Process. Metallizing Engineering Co., Inc. (9-105)

ORGANIC FINISHING

Corrosion-Resistant Coatings. Carbozite Corporation. (9-202)
Corrosion-Resistant Coating. Corrosion Control Corp. (9-163)
Organic Metal Coatings. E. I. du Pont de Nemours & Co., Inc.; Rubber Chemicals Div. (9-201)
Lacquers. Egyptian Lacquer Mfg. Co. (9-183)
Wax Over Black Oxidizing Finishes. S. C. Johnson & Son, Inc. (9-179)
Wrinkle Finishes. New Wrinkle, Incorporated. (9-199)
Paint, Enamel and Lacquer Data Sheets. Roxalin Flexible Finishes Co. (9-127)
Spray Finish Machines. Spray Engineering Co. (9-182)

PICKLING

Pickling Inhibitor. American Chemical Paint Co. (9-208)
Corrosion Resistant Ceramics. Atlas Mineral Products Co. (9-72)
Pickling of Steel. Enthone Company. (9-162)
Ferric Sulphate and Cartridge Cases. Monsanto Chemical Co., Merrimac Div. (9-176)

POLISHING

Greaseless Abrasive Compound for Burring. Lea Manufacturing Co. (9-142)

10. Testing · Control

CONTROL INSTRUMENTS

Precision Control. Brown Instrument Co. "The Technique of Precision Control in Industrial Processes" is the title of an ambitious 64-page booklet. The many illustrations are taken from current practice in varied industries and include schematic diagrams of basic control systems and photos of apparatus. (10-317)

Operation-time Recorders. Foxboro Company. In bulletin A-321 is presented both electric-operated and mechanical recorders. Their importance in test engineering, setting job standards, cost accounting and production control are outlined. (10-321)

Temperature Controllers. Wheelco Instruments Co. Photographs and text make up a 4-page bulletin, "Wheelco Comments," Vol. 2, No. 2. It also includes a list of sales and service headquarters in many cities. (10-316)
Controlling Gas Pressure. Bristol Company. (10-296)
Heat Controls. Burling Instrument Co. (10-307)
Thermocouple Protecting Tube. Elematic Sales Corp. (10-198)
Pyrometer Control. Illinois Testing Laboratories, Inc. (10-42)
Immersion Pyrometer. Pyrometer Instrument Co. (10-8)
Thermocouples and Accessories. Arklay S. Richards Co., Inc. (10-265)

HARDNESS TESTING

Hardness Tester for Soft Metals. Barber-Colman Co. (10-218)
Ferrous and Non-Ferrous Hardness Tester. Clark Instrument, Inc. (10-236)
Microhardness Tester. Eberbach & Son Co., Inc. (10-156)
Diamonds for Hardness Testers. Industrial Diamond Co. (10-286)
Portable Brinell Hardness Tester. Andrew King. (10-148)
Surface Finish Tester. Taber Instrument Co. (10-153)

INSPECTION DEVICES

Magnifiers for Inspection. Stanley Works. This single illustrated sheet describes inspection tools that combine magnification and shadow-free fluorescent lighting, designed for inspectors, machinists and toolmakers. (10-325)

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Wear Gage. American Instrument Co. (10-303)
Magnification in Industry. Boyer-Campbell Co. (10-294)
Surface Smoothness Tester. Brush Development Co. (10-192)
Precision Gages. Federal Products Corp. (10-94)
Electronic Micrometer. Instrument Specialties Co., Inc. (10-228)
Carbon Meter. E. Leitz, Incorporated. (10-202)
Magnaflux. Magnaflux Corporation. (10-288)

MECHANICAL TESTING

Stress-strain Recording. Baldwin Southwark Div., Baldwin Locomotive Works. The 20-page book is designed for engineering staffs in many industries. Included are specification data of the Army and Navy, requirements for testing war material, and interpretation of the stress-strain curve (10-318)

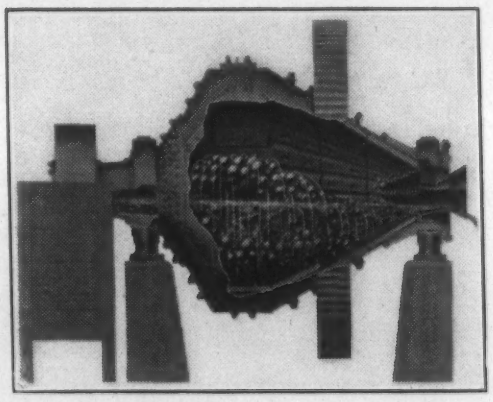
Balancing Machines. Bear Mfg. Co. This booklet describes machines for balancing armatures, fans, wheels, gears, etc. and its importance in eliminating noise and premature wear due to excessive vibration resulting from couple action. (10-320)

Electric Strain Gage. General Electric Co. (10-232)
Physical Testing Equipment. W. C. Dillon & Co., Inc. (10-227)

RECOVER METAL

From Your

WASTE PILE



Reclaim the Valuable Metal From Slag, Dross, Ashes, Skimmings or Sweepings.

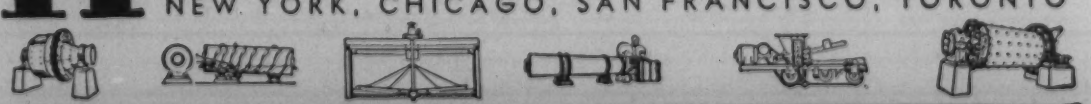
The Conical Ball Mill Separates the Metal From the Waste At A Low Cost.

No Grate Used—Will Not Clog.

Bulletin No. 8

HARDINGE

COMPANY, INCORPORATED - YORK, PENNSYLVANIA
NEW YORK, CHICAGO, SAN FRANCISCO, TORONTO



CONICAL MILLS | COUNTER CURRENT CLASSIFIERS | THICKENERS CLARIFIERS | RUGGLES-COLES DRYERS | CONSTANT WEIGHT FEEDERS | TUBE ROD AND BATCH MILLS

Fatigue Testing Machines. Krouse Testing Machine Co. (10-201)
Impact Testing Machine. Tinius Olsen Testing Machine Co. (10-298)
Universal Testing Machines. Riehle Testing Machine Div., Am. Machine & Metals, Inc. (10-144)
Tensile Testing of Fine Wire. Henry L. Scott Company. (10-55)

METALLOGRAPHIC EQUIPMENT

Metallurgical Polishing Equipment. Tracy C. Jarrett. Here are 12 pages of original design, describing requirements for modern metallographic inspection, the Jarrett submerged specimen cutter, the mounting press and the polishing machine. (10-319)
Metallurgical Laboratory Equipment. Adolph I. Buehler. (10-199)
Presses for Mounting Metallographic Specimens. Fred S. Carver. (10-255)
Metallographic Polishing Machine. Cincinnati Electrical Tool Co. (10-193)
Electronic Photometer. Photovolt Corporation. (10-268)
Data on Electron Microscope. R.C.A. Manufacturing Co. (10-302)
Metallographic Polishing Powder. Conrad Wolff. (10-306)

RADIOGRAPHY

Industrial X-ray Units. General Electric X-ray Corp. A complete line of industrial X-ray equipment in powder ranges up to one million volts is described and illustrated in this useful 20-page booklet. (10-324)
Industrial X-ray Cassettes. Picker X-ray Corp. Ruggedly-built cassettes, specially designed for the heavy and high-production service of industrial radiography, are described along with other X-ray supplies in a 6-page folder. (10-322)
X-ray Films. Agfa Ansco. (10-315)
Industrial Radiography with Radium. Canadium Radium & Uranium Corp. (10-261)
Modern Industrial Radiography. Eastman Kodak Co. (10-177)
Industrial X-ray. Kelley-Koett Manufacturing Co., Inc. (10-185)
X-ray Diffraction Tubes. Machlett Laboratories. (10-300)
X-ray Tubes and Equipment. Philips Metalix Corp. (10-301)
X-ray Machine. Standard X-ray Company. (10-299)

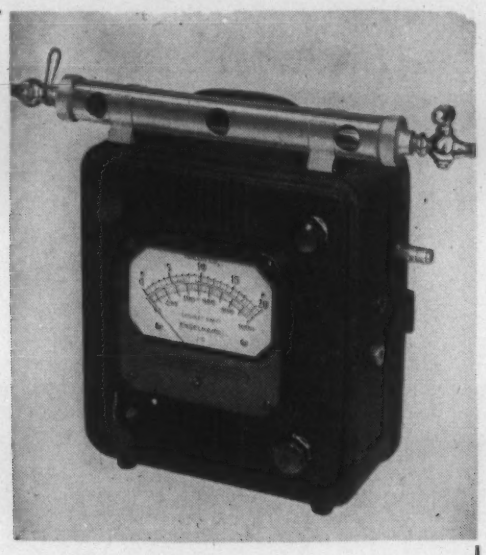
SPECTROGRAPHY

Analyzing Spectrographic Plates or Film. Leeds & Northrup Co. (10-205)
Universal Spectrophotometers. Wilkens-Anderson Company. (10-180)

LABORATORY AIDS

Determination of Combined Nitrogen in Steel. Burrell Technical Supply Co. (10-243)
Laboratory Equipment. Laboratory Equipment Corp. (10-194)
High Speed Electrolytic Analysis. E. H. Sargent & Company. (10-219)

1 INSTRUMENT
2 OPERATION
3 READING



Determines

Flue Gas Temperature *AND* CO_2 Content

Simultaneously!

THE ENGELHARD FLUALYZER

is an extremely accurate portable instrument to determine temperature and carbon dioxide content of exhaust gases.

The FLUALYZER combines the time-proven Wheatstone Bridge Circuit for CO_2 analysis with a thermocouple circuit for temperature registration. . . . Both the CO_2 and temperature readings can be taken — *directly* and *simultaneously* — from a double range indicator calibrated from 0 to 20% for CO_2 and from 0 to 1000°F. . . . Only one flue tap is required for a reliable determination of both factors.

FLUALYZER will save you Money—Time—Effort in these and many other gas analyzing operations:

• Oil Burner Adjustments • Calcination • Boiler Firing Control

Write today for Bulletin 700

CHARLES ENGELHARD, INCORPORATED
90 CHESTNUT ST., NEWARK, NEW JERSEY

11. General

Electric Heaters. General Electric Co. "Electric Heat in Industry" appears on the title page of this 8-page bulletin. The book is well balanced as between text and illustration. (11-76)
Blowers. Ilg Electric Ventilating Co. This 7-page booklet is largely pictorial in offset duotone, of interest to many lines, including portable fume exhausters for welders in shipyards. (11-77)
Mounted Wheels for Portable Tools. Chicago Wheel & Manufacturing Co. (11-70)
Magnets and Magnetic Separators. Dings Magnetic Separator Co. (11-49)
Conservation Control Plan. Henry Disston & Sons, Inc. (11-45)
Chemicals for All Industries. E. I. du Pont de Nemours & Co., Inc., R. & H. Chemicals Div. (11-33)
Dryers, Kilns, Coolers. Hardinge Company. (11-64)
Acid Proof Cement. Pennsylvania Salt Mfg. Co. (11-16)
Water Softeners. Permutit Company. (11-75)
Safety Enclosures. Strand Manufacturing Co. (11-74)
Survels. Trabon Engineering Corp. (11-72)

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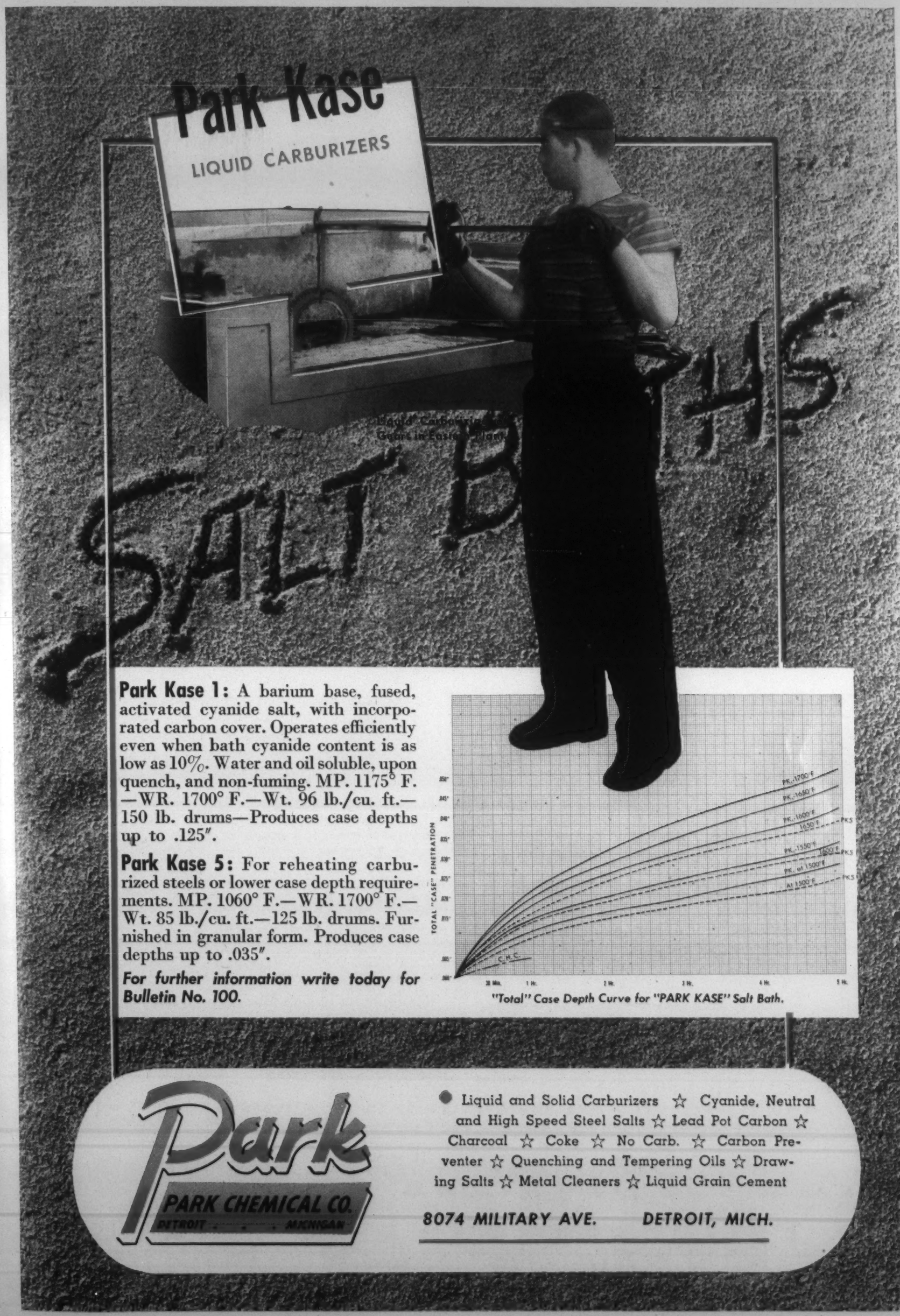


Park Kase 1: A barium base, fused, activated cyanide salt, with incorporated carbon cover. Operates efficiently even when bath cyanide content is as low as 10%. Water and oil soluble, upon quench, and non-fuming. MP. 1175° F. —WR. 1700° F.—Wt. 96 lb./cu. ft.—150 lb. drums—Produces case depths up to .125".

Park Kase 5: For reheating carburized steels or lower case depth requirements. MP. 1060° F.—WR. 1700° F.—Wt. 85 lb./cu. ft.—125 lb. drums. Furnished in granular form. Produces case depths up to .035".

For further information write today for Bulletin No. 100.

"Total" Case Depth Curve for "PARK KASE" Salt Bath.

Park

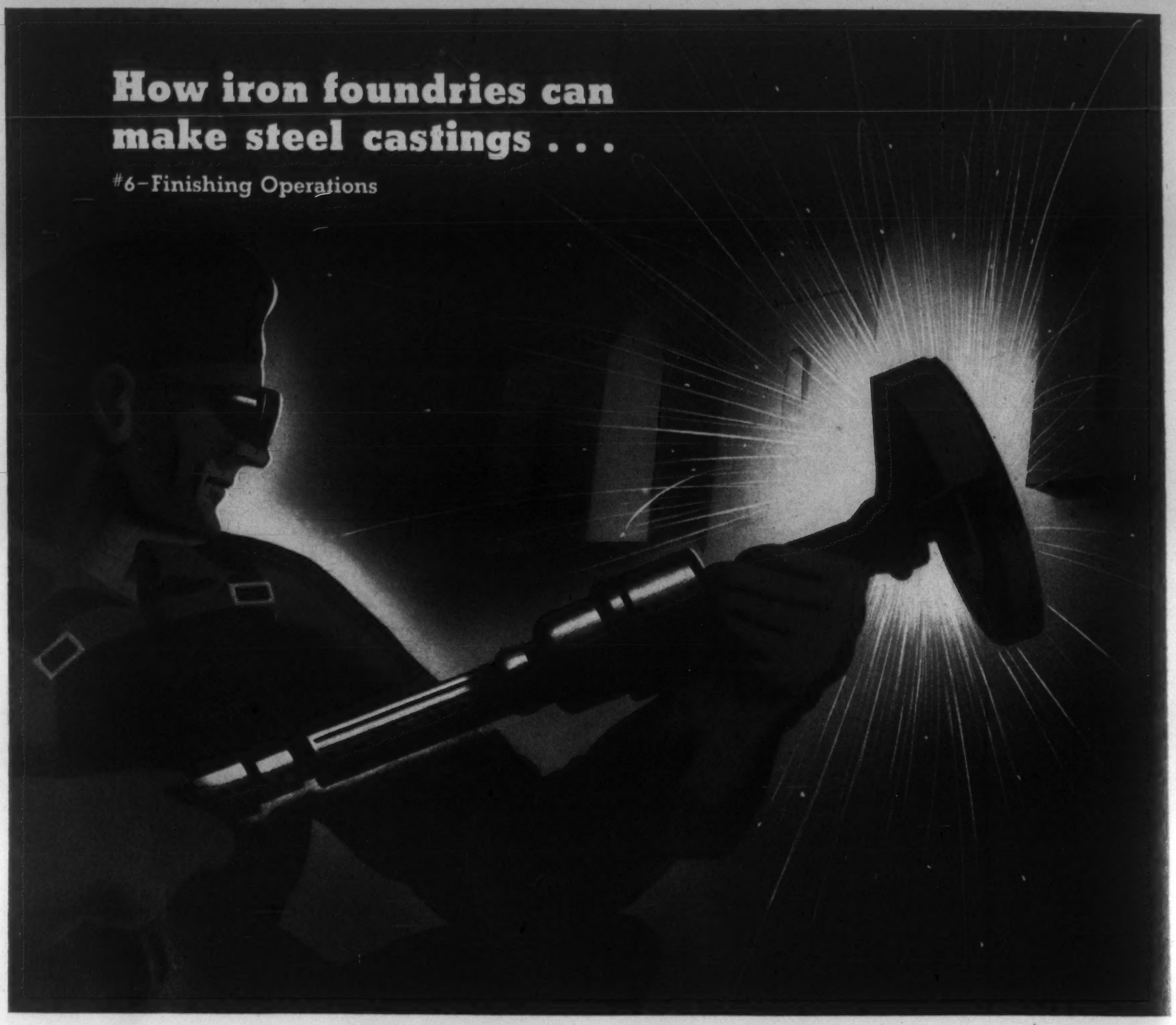
PARK CHEMICAL CO.
DETROIT MICHIGAN

● Liquid and Solid Carburizers ☆ Cyanide, Neutral and High Speed Steel Salts ☆ Lead Pot Carbon ☆ Charcoal ☆ Coke ☆ No Carb. ☆ Carbon Preventer ☆ Quenching and Tempering Oils ☆ Drawing Salts ☆ Metal Cleaners ☆ Liquid Grain Cement

8074 MILITARY AVE. DETROIT, MICH.

How iron foundries can make steel castings . . .

#6–Finishing Operations



Information furnished by "Metals and Alloys"

An outstanding difference between iron and steel foundry practice is the extensive and expensive nature of the "finishing" operations—cleaning, grinding, welding, heat treating, etc.—applied to steel castings.

A typical sequence of finishing operations (1) removal of small gates with a sprue cutter, (2) blast cleaning, (3) flame-cutting of large gates and risers, (4) grinding, (5) chipping with pneumatic hammers, (6) welding, (7) grinding off of excess weld metal, (8) annealing or heat treating, and (9) blast-cleaning to remove heat treating scale.

Special attention must be given to annealing and heat treating. These operations should be carried out under the supervision of a metallurgical engineer, who will specify temperatures and cycles for the different types of steel processed. Automatic temperature control equipment is a necessity if ordnance specifications for castings quality are to be met.

Conversion of iron foundries to steel casting manufacture is entirely practicable if the plant capacity, technological requirements and probable costs are intelligently appraised.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

Climax Mo-lyb-den-um Company
500 Fifth Avenue • New York City

MOLY

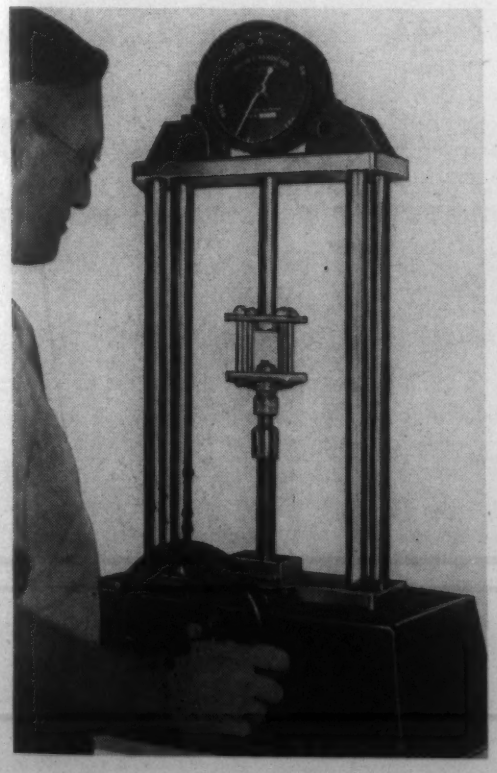
METALLURGICAL ENGINEERING news

Equipment • Finishes • Materials • Methods • Processes • Products
Alloys • Applications • Designs • People • Plants • Societies

Versatile Tensile Tester

The new Model-B tensile tester of *W. C. Dillon & Co., Inc.*, 5410 W. Harrison St., Chicago, has been made more versatile. It is an "in-between-size" instrument. It will physically check specimens up to 1 ft. long and 9 in. wide, and also goes into the range of larger machines, handling up to 10,000 lbs.

Paper, plastics, metal, rubber, wood, etc. may be checked readily for elasticity,



etc. so long as their breaking point lies between zero and 15,000 lbs. (as a number of capacities are now available in that range). Height of machine starts at 32 in. (table model) up to 78 in. (floor type.)

A separational pull test of an aircraft socket is being demonstrated in the accompanying illustration.

● Hipersil steel has been developed by *Westinghouse Electric & Mfg. Co.*, East Pittsburgh, Pa., in the place of a nickel alloy in the manufacture of Ignitrons, devices for converting a.c to d.c. in manufacturing aluminum and magnesium and for other purposes. Hipersil is a silicon steel, carrying one-third more magnetism than ordinary steel.

Society Has New Corrosion Division

A Corrosion Division of the Electrochemical Society has been organized. Its object is to coordinate the interests of the society relating to corrosion with individuals and organizations that are particularly interested and active in this field, to solicit papers and plan symposia. Even persons who are not members, but who are particularly interested in corrosion work, are invited to join the Electrochemical Society and participate in the work of the Corrosion Division.

The chairman is L. G. Vande Bogart, Research & Development Laboratories, Crane Co., 836 S. Michigan Ave., Chicago; vice-chairman is H. H. Uhlig, General Electric Co., Research Laboratory, 1 River Road, Schenectady; secretary-treasurer, R. H. Brown, Metallurgical Div., Aluminum Research Laboratories, Aluminum Co. of America, New Kensington, Pa.

Multi-Purpose 100-Ton Press

A multi-purpose, open-side press for various operations in the fields of assembling, pressing and straightening has been brought out by the *Denison Engineering Co.*, 1152 Dublin Road, Columbus. It has a 100-ton capacity, suitable for small lot or production line work.

Compact design where space is limited is a feature, its base being 64 in. and depth 40 in., standing 11 ft. 6 in. high. It is readily adaptable for various special operations by alteration of certain key parts. It uses oil for transmission of power, hence

the trade name, "HydrOILics". Tonnage exerted by the press ram ranges from 10 tons to full capacity.

How Re-Checking of Specifications and Design *Can Save Scarce Metals*

In waging this war, the strategic metals required for machines and equipment producing war material are just as important as the material itself, for without one the other could not be.

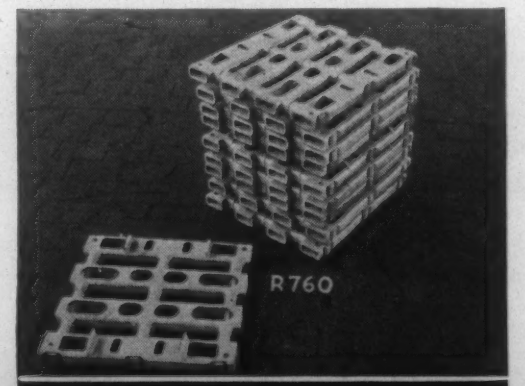
In designing chromium-nickel castings for heat-treating equipment, Amsco engineers steadfastly strive to reduce the consumption of these suddenly precious metals. Their recommendations have resulted in the scaling down of metal requirements in numerous instances.

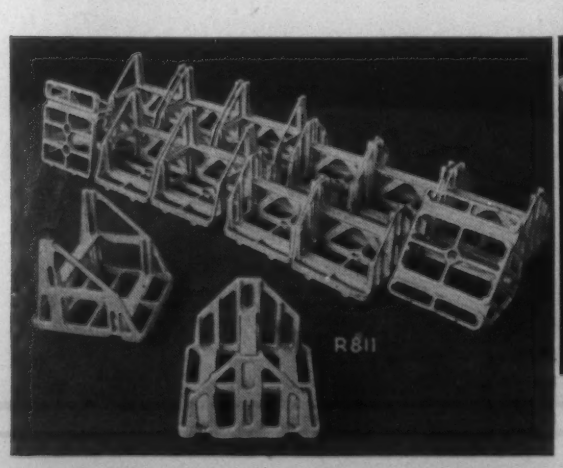
In a recent case we were asked to quote on 3½ tons of furnace castings of Amsco Alloy grade F-1, which contains 35% nickel and 15% chromium, or approximately 2,500 lbs. of nickel and 1,000 lbs. of chromium.

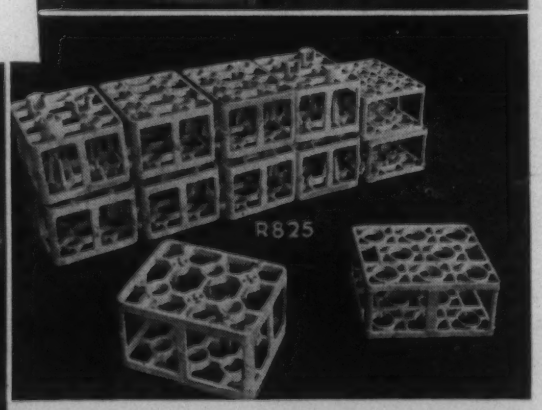
The specifications called for castings of metal sections 1″ thick, but our engineering data indicated that a ¾″ or ⅝″ metal section would probably be sufficient. Accordingly, we suggested that our engineers be permitted to re-check the operating conditions to substantiate our belief.

The revision of specifications stood to save 1,500 lbs. of nickel and 400 to 500 lbs. of chromium. From a foundry standpoint, it is preferable at times to cast thicker metal sections as a factor of safety to avoid discounts, but believing this is no time for the avoidance of risks at the expense of much-needed metals, we were willing to make these castings of minimum practical metal sections. The lowered cost for this customer is incidental to the conservation of scarce metals.

Obviously, such savings are not possible in every application—but designs and specifications should be critically examined for such opportunities.







Typical Amsco Alloy furnace parts and fixtures:
R-760—Tray assemblies for handling tractor gears and parts in a continuous type furnace, through an oil quench and on through a "draw" furnace.
R-811—Fixtures for holding track and tank parts during gas carburizing in a muffle type furnace.
R-825—Analysis F1-N furnace fixtures. Top and bottom grilles cast separately are welded together. Pins and shafts for tanks are held vertically for carburizing.

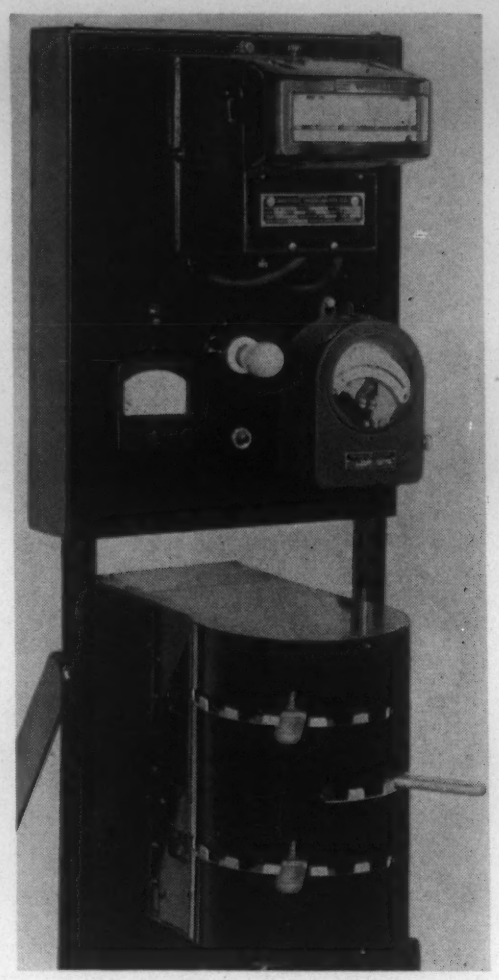
Junk your scrap now!

Amsco
AMERICAN MANGANESE STEEL DIVISION
OF THE AMERICAN BRAKE SHOE & FOUNDRY CO.
Chicago Heights, Illinois
FOUNDRIES AT CHICAGO HEIGHTS, ILL.; NEW CASTLE, DEL.; DENVER, COLO.; OAKLAND, CALIF.; LOS ANGELES, CALIF.; ST. LOUIS, MO
OFFICES IN PRINCIPAL CITIES

Genuine Manganese Steel, "The Toughest Steel Known"
Chromium-Nickel Alloy Castings for heat and corrosion
Power Shovel Dippers. Dredge and Industrial Pumps
Welding Materials for reclamation and hard-surfacing

Temperature Control for Salt Baths

A new temperature control for salt bath heat treating, described as foolproof, measures and adds the correct amount of power for the proper interval and corrects the operator for any error in setting the control.



It is made by the *Upton Electric Furnace Div., Commerce Pattern Foundry & Machine Co.*, 7450 Melville Ave., Detroit.

It permits prediction of size change to closer limits, thereby eliminating much, if not all, finish-grinding on many high-speed steel cutting tools.

The control keeps the heat on at all times, but at a low value. When work is inserted in the bath, the control adds a definite amount of heat for a specific interval. When the interval is ended, it reduces the power back to a holding level and warns the operator to remove the work. If the operator makes as little as 3 deg. F. error in his settings, the controller warns him.

Screw Improves Wet Disposal Unit

A screw conveyor feed has been added to the American Wet Disposal Unit, *American Foundry Equipment Co.*, Mishawaka, Ind., to provide a constant and uniform rate of feed of discharged dust from dry type dust collectors into the sludge forming device.

Dust that falls from the collector hopper through a flexible coupling is deposited directly into the screw conveyor, the rate of feed into the mixing chamber being controlled by a gear speed reducer and variable speed motor pulley. Simultaneous with the entrance of dust into the unit, liquid is mixed with it. Any desired consistency of the resulting sludge can be attained by controlling the volumes of dust and water.

Here's what a western machine company has to say about Graphitic Steel . . . .

"We discussed this point with all of our experienced men and asked them of the relative qualities of Graphitic Steel, compared to other steels we had used. Their reply was unanimous—that the Timken Graphitic Tool Steel we had so far exceeded the other steels we had used in machinability that it was hard to convince them that it was actually a high carbon tool steel . . .

"In conclusion, I would say that for unparalleled machining qualities, for the most ready response to heat treatment, for non-deforming qualities, and for final finishing, it is the writer's opinion that Graph-Mo Tool Steel has no superior."

Graphitic Steel will speed your war production now and help you speed up post-war production for profit.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

Steel and Tube Division

Manufacturers of Timken Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; Timken Alloy Steels and Carbon and Alloy Seamless Tubing; and Timken Rock Bits.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
GRAPHITIC STEELS

TO ASSURE VICTORY
BUY UNITED STATES WAR SAVINGS BONDS & STAMPS

Non-Magnetic Manganese Alloy

A new non-magnetic manganese alloy has been brought out by *General Electric Co.*, Schenectary. to replace the formula involving 18 per cent chromium, 8 nickel, the remainder iron. Both alloys require a covering to permit soldering and, for the tin coating previously used, lead has been substituted.

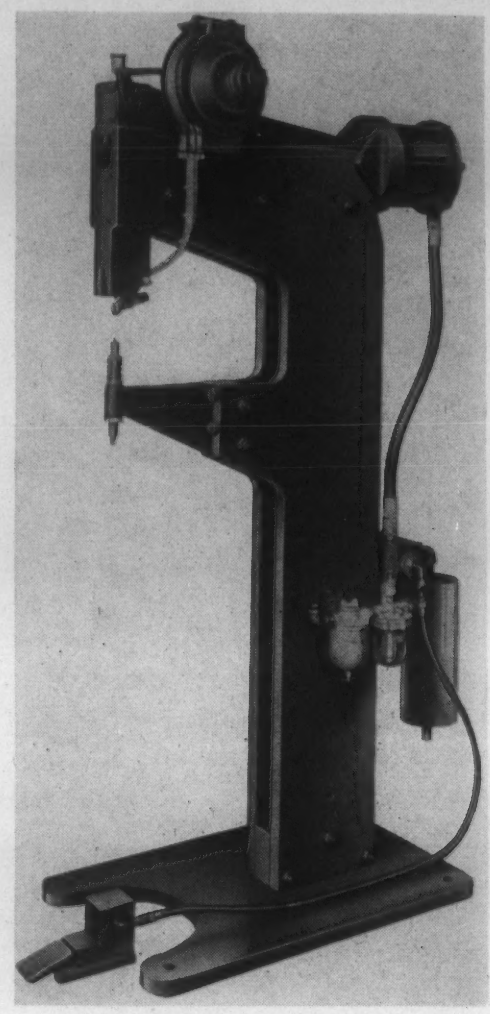
The company claims that the new formula provides a much stronger alloy that will continue in general use when the war ends. It is now used in motor-generators for submarines, control equipment and motors for war industry generally. In wire form it is used in electric locomotives.

Machine for Aluminum Alloy Riveting

For flush riveting in aircraft production, the new "Rivitor", made by the *Tomkins-Johnson Co.*, Jackson, Mich., is air powered with automatic feed and setting mechanism. It is built of less critical materials and requires fewer parts.

Air pressure from the cylinder is applied (and stepped up) through a toggle mechanism. It handles exclusively aircraft requirements for aluminum alloy riveting, with capacity for rivets ¼ in. diam. x ¾ in. long.

A different type of rivet set and rivet jaw construction allows it to be adapted to handle counter sunk head, round head,



full and semi brazier rivet heads. It is available in throat depth ranging from 9 to 36 in.

Other features include precision setting, adjustable setting tools and interchangeable horn-type construction.

New 150-Ton Inclinable Press

Features of a new 150-ton inclinable press made by *E. W. Bliss Co.*, 53rd St. & Second Ave., Brooklyn, are the smooth-faced frame, the enclosed operating mechanism (including clutch, flywheel and brake), clutch operating valves and electrical controls, together with a spring counter balance for the slide, which are mounted inside the frame giving an attractive appearance.

The press can be inclined 39 deg. to allow the completed work to fall by gravity to the rear of the machine.

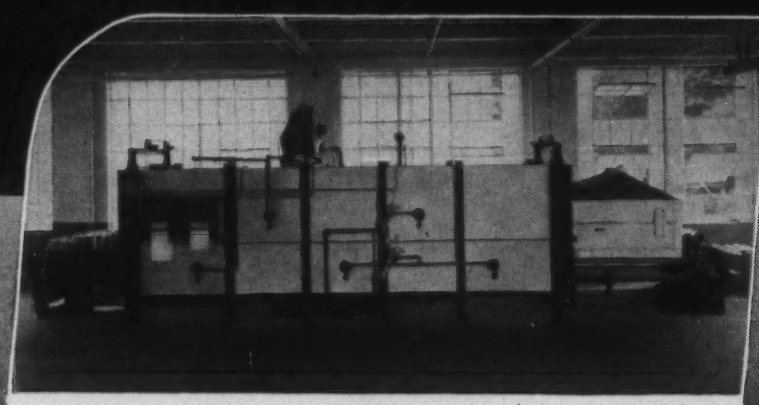
Meetings and Expositions

- SOCIETY OF AUTOMOTIVE ENGINEERS, War Production-Engineering meeting. Detroit, Mich. Jan. 11-1, 1943.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, winter convention. New York, N. Y. Jan. 25-29, 1943.

Heat-Treating

STEEL Shell Cases



R-S QUALITY PRODUCTS SINCE 1908

The substitution of steel for brass in the manufacture of cartridge and shell cases required considerable research in the selection of a suitable deep drawing steel having the desired physical properties.

Of equal importance is the selection of Heat-Treating Equipment capable of uniformly producing cases in which these properties have been retained.

R-S Furnaces for intermediate and final anneals will meet the most exacting requirements. Ask for details and constructive suggestions.

FURNACE DIVISION

R-S PRODUCTS CORPORATION

4522 Germantown Ave., Philadelphia, Pa.

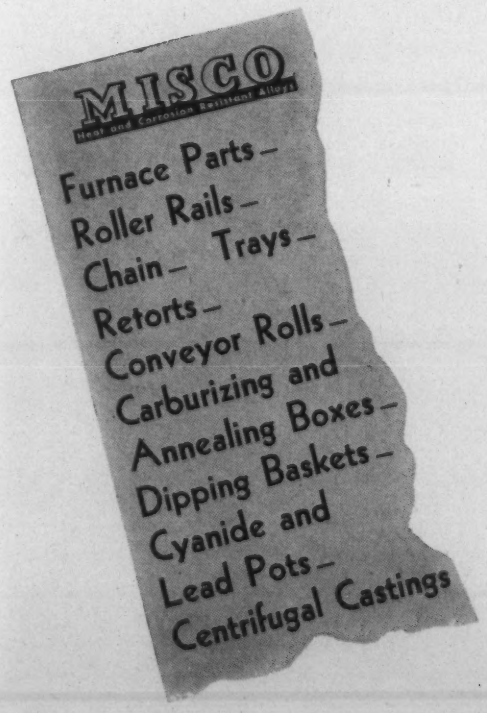
R-S Furnaces of Distinction

Annealing • Car Hearth • Continuous Conveyor
Forging • Billet Heating • Plate and Angle Heating
Convection • Rotary Hearth • Salt Bath • Metal Melting

BUY WAR BONDS

MISCO

HIGH TEMPERATURE ALLOY SHEET WALL CARBURIZING BOXES



MISCO sheet carburizing boxes are at least 50% lighter than cast boxes of equal capacity.

Their construction is planned for most efficient service. Thermal stresses are reduced and pound for pound they last longer. They heat rapidly, save fuel, and reduce handling time. Based on our experience with thousands of carburizing boxes of all types, they afford maximum service per dollar of investment, and provide the greatest output in a given period of time.

Michigan Steel Casting Company

One of the World's Pioneer Producers of Heat and Corrosion Resistant Alloy Castings

MISCO
Heat and Corrosion Resistant Alloys

1981 GUOIN STREET • DETROIT • MICHIGAN

News of Metallurgical Engineers

W. A. Schlegel, Metallurgical Dept., Carpenter Steel Co., was awarded the Henry Marion Howe Gold Medal by the American Society for Metals, for his technical paper on "Surface Carbon Chemistry and Grain Size of 18-4-1 High Speed Steel." Mr. Schlegel has been with the Carpenter Company since graduation from college in 1927. During the last four years he confined his work to practical research work in heat treating.

Julius Clauss, Detroit, has been named assistant in production problems, Iron & Steel Branch, WPB. He was chief engineer of the Great Lakes Steel Corp. and is a specialist on problems relating to the construction of steel plant facilities. At various times he has been affiliated with five steel companies.

Anson B. Albree and *T. G. Bergin* have joined the A. F. Holden Co., New Haven, Conn., as metallurgical engineers. Mr. Albree was formerly assistant metallurgist at Wetherell Bros. Co., Cambridge, Mass. and more recently with the Bridgeport Grinding Machine Co., West Haven, Conn., as purchasing agent and metallurgist. In his new position he is assigned to research and development of new products. Mr. Bergin was formerly with American Steel & Wire Co. at Worcester in the open-hearth, rolling mill, wire mill and metallurgical departments and for the past four years at the New Haven plant as works metallurgist, specializing on high carbon heat treating and wire drawing. He is now in charge of the wire heat treating division at Holden.

Charles R. Foreman and *Earl H. Seelbach* have joined Park Chemical Co., Detroit. Mr. Foreman, formerly in the metallurgical department of Oldsmobile at Lansing, Mich., has a similar position with Park Chemical. Mr. Seelbach represents Park Chemical for the sale of heat treating products and allied materials from Syracuse to Buffalo.

Edwin H. Brown, engineering vice-president of the Allis-Chalmers Mfg. Co., has been made assistant chief of the Iron & Steel Branch, WPB, in charge of the plant facilities section.

Dan C. Hungerford has been elected president and general manager of Aircraft Products Development Corp., Summit, N. J. He was graduated from the College of Engineering, University of Michigan, in 1927. He was previously vice-president and director of the Elastic Stop Nut Corp., Union, N. J. and prior to that was president of the Standard Mfg. Co., Corning, N. Y.

Alexander C. Brown, Cleveland, has been named deputy chief of the Iron & Steel Branch, WPB. He has been first vice president of the Cleveland Cliffs Iron Co. since 1934. He was educated at Yale and Case School of Applied Science.

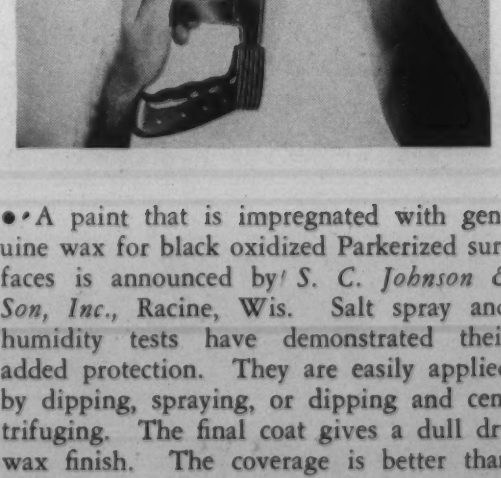
Charles Hotchkiss Norton, known as the "father of cylindrical grinding" died recently at his home at Plainville, Conn. at the age of 91. He first became associated with Norton Co. in 1900 when the then Norton Emery Wheel Co. founded the Norton Grinding Co. with Mr. Norton as designer and chief engineer. The methods he introduced and the machinery manufactured by Norton Grinding Co. worked an economic revolution in the mechanical industries and made it possible to produce precision ground cylinder parts of machinery in less time than the crude work required previously. Mr. Norton held more than 100 patents and has written for technical journals and delivered many lectures in technical subjects. He was awarded the John Scott Medal "for the invention of accurate grinding de vices of high power," the honor marking world-wide recognition of his inventions.

New Hack Saw Frame

Loose blade studs and threaded tension devices have been eliminated in a new type of hack saw frame introduced by *Victor Saw Works, Inc.,* Middletown, N. Y. Blades are released or set-up in a jiffy by a simple cam-action lever-lock.

Made of heat-treated spring steel, this Victor frame is more rigid than other adjustable frames, state the makers. The finish is gun metal, and the frame is available with either pistol grip or straight handle.

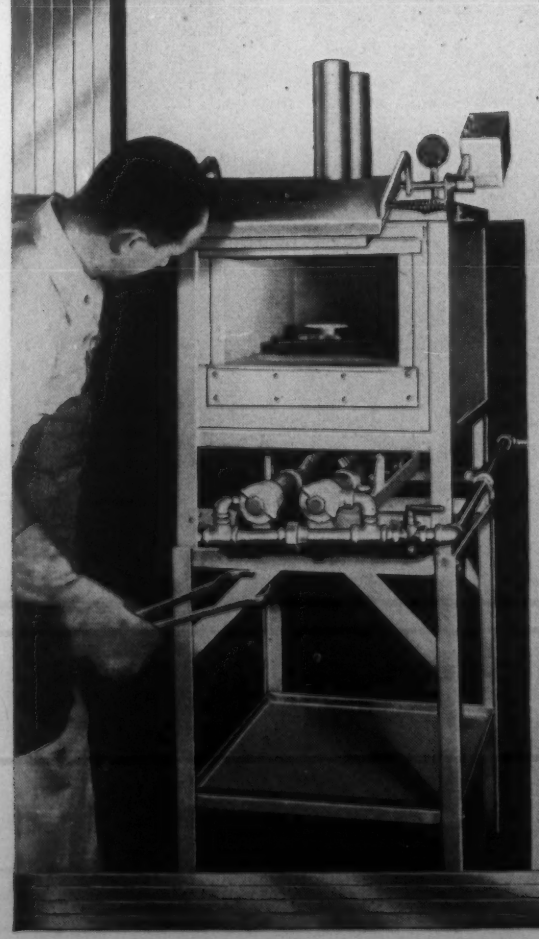
To adjust for 8 to 12-in. blades, the operator pulls out a pivot pin to open position, slides the frame, then snaps the pivot pin back into place.



• A paint that is impregnated with genuine wax for black oxidized Parkerized surfaces is announced by *S. C. Johnson & Son, Inc.,* Racine, Wis. Salt spray and humidity tests have demonstrated their added protection. They are easily applied by dipping, spraying, or dipping and centrifuging. The final coat gives a dull dry wax finish. The coverage is better than oil.

Baker Gas Furnaces

TEMPERATURES UP TO 2400° F. WITHOUT A BLOWER



BAKER Blowerless Gas Furnaces are very low in gas consumption, noiseless in operation, reach the required temperature rapidly and are equipped with thermocouple and accurate pyrometer. The research departments of some of the largest corporations have contributed to making their high efficiency possible.

There are 9 standard stock models ranging in size from No. 1 (Bench type), which is 6″ x 8″ x 5½″, to No. 24, which is 12″ x 20″ x 8″ as illustrated. All provide uniform, controlled heat up to 1900° F.

Model No. 5, 6″ x 12″ x 5″, is built especially for treating high speed steel. Gives uniform, controlled temperatures up to 2400° F.

We stock one Hydrogen Atmosphere furnace, No. 12, with a closed muffle 8½″ x 15″ x 2½″ high.

Special size furnaces built to your order. Write for descriptive folder and prices.

BAKER & CO., INC.

113 Astor St., Newark, N. J.

SMALL METAL TUBING
is Our Only Business
and We Know It . . .

(MAXIMUM O.D. 5/8" IN MANY METALS)

SUPERIOR

The big name in
SMALL TUBING
for Uncle Sam!

SUPERIOR TUBE COMPANY, NORRISTOWN, PENNSYLVANIA

FOR EVERY SMALL TUBING APPLICATION

Tubing from 5/8" OD down **...SUPERIOR Seamless in various analyses. WELDRAWN Welded and drawn Stainless. BRAWN Welded and drawn "Monel" and "Inconel". SEAMLESS and Patented LOCKSEAM Cathode Sleeves.**

High Speed Degreasing Solvent

Cyclodiene Hydrocarbon is described as a high-speed solvent cleaning non-aqueous degreasing solvent for all metals. The work is dipped into the solvent at room temperature and comes out thoroughly degreased. A rust inhibitive thin protective film remains on the work 20 min. before complete evaporation.

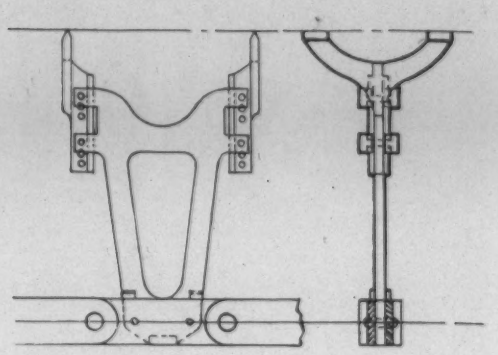
It can serve as an alternate for vapor degreasing, chlorinated hydrocarbons, aqueous alkaline degreasers, benzenes, etc. for use in plating, painting, Parkerizing, anodizing or other finishing. The supply is not restricted by priorities. It is sponsored by the *Colonial Alloys Co.*, Philadelphia.

Renewable Carrier Blades in Furnaces

The Lerner renewable-tip carrier blade, used in conveyor chains in steel treating furnaces for normalizing steel sheets, provides a simple means for replacing the upper quarter, which moves in the hot zone of the furnace, thereby conserving chromium and nickel alloy.

The lower part of the carrier blade moves along a slot in the furnace hearth and is largely protected from severe heat and corrosion by the refractories enclosing them.

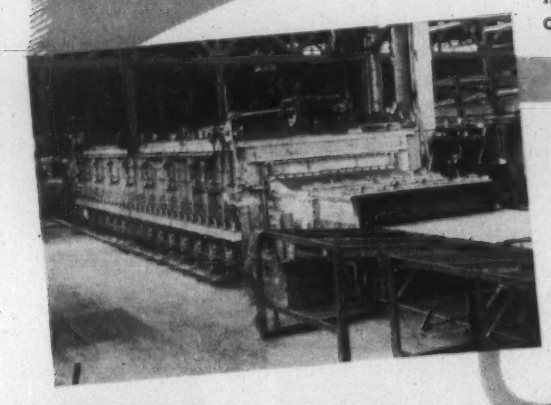
No welding is necessary, and after a tip is burned off it can be repointed and moved up into proper position again to carry its part in the load. It is made



by the *American Manganese Steel Div., American Brake Shoe & Foundry Co.*, Chicago Heights, Ill.

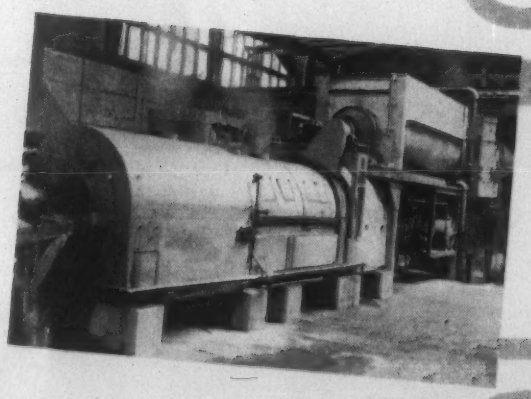
FURNACES THAT SAY IT WITH PRODUCTION

In the heat treatment of shells and other defense products, Rockwell Furnaces speak for themselves. Here are several of the many types that say it—convincingly—in terms of production.



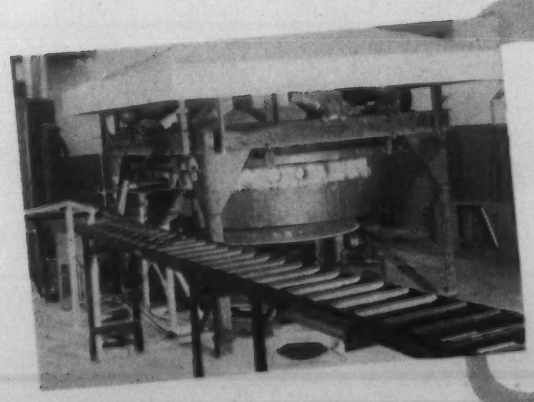
18,000 LBS. PER HOUR

This Gas Fired Roller Hearth Annealing Furnace handles cartridge brass slabs. Construction is unusually rugged — the rolls are extremely heavy, and the drive and all other parts are capable of this extreme production rate. Driven rolls carry the slabs from the charging table through preheating, heating and cooling sections, and on the discharge table to the dump mechanism.



3,000 LBS. PER HOUR

A Gas Fired Revolving Annealing Furnace (Retort Type) that is a complete unit for washing, annealing and pickling 50 caliber brass cartridge cups in a continuous, even stream. A great producer, it is also exceptionally economical from the standpoint of labor, fuel and in the use of acid.



70 SHELLS (4.5") PER HOUR

A Revolving Hearth Type Shell Nosing Furnace with openings around its outside circumference for receiving the shells. Heating is so controlled that no distortion occurs below the taper during the press operation. Charging and discharging from the same position requires only one operator—shells being sent to him on a conveyor. The absence of a water-cooled chill results in a great saving of fuel.

Because of standards already established, time-saving deliveries can be made on many types of Rockwell Furnaces that will step up your production. What is your heat treating problem?

ROCKWELL SINCE 1888 BUILT

W. S. ROCKWELL CO.

50 CHURCH STREET NEW YORK, N. Y.

Induction Heating Speeds Tin Plate Output

Heating tin electrolytically deposited on steel sheet with high frequency current at 200,000 cycles per sec. melts the tin thus deposited, saves critical tin, speeds production and increases corrosion protection, according to statements of engineers of the *Westinghouse Electric & Mfg. Co.* at a recent demonstration at the company's Radio Division in Baltimore before representatives of the trade and technical press.

Already at work in a big steel mill, the first commercial installation of this process is now producing about 60 tons a day of 14-in. strip tin-plate. The dull, rough, electrolytically tinned steel sheet is passed into an induction coil where it is heated to the fusion point of tin, which then flows into a bright, uniform surface ready for the can maker. This treatment virtually makes a finished product of the material.

Present electrolytic lines operate at a speed of 500 ft. per min., but in the near future it is expected they will go up to 1000 ft. per min. The induction heating method, it is claimed, can easily match these speeds so that it can be put right in the production line. A widespread use of this development is expected as the method of electrolytic timing gains in adoption.

The idea of using radio waves to heat the tin coating to a point where it would flow evenly on the steel foundation was conceived by Glenn E. Stolz, manager of the metal working section of the Westinghouse engineering department.

● A feature of a new silver solder flux is its low breaking point, becoming completely fluid at about 1065 deg. F. It is so balanced that it does not crystallize, and when diluted correctly with water, remains uniform. During brazing it throws off a soft green transparent flame, permitting full vision. It is especially suitable for stainless iron and steel and various non-ferrous metals. It is used by the Navy, and is made by *American Products Corp.*, 422 South Dearborn St., Chicago.

The Influence of

EXAMPLE

THE hand of experience is the guide of the Neophyte.

It is one thing to influence people by dictating orders. It is quite another thing to influence men by means of EXAMPLE.

Edmund Burke, in his "Regicide Peace" says, "Example is the school of mankind and they will learn from no other."

We believe that all business can be kept on a higher plane by the INFLUENCE OF EXAMPLE in striving for better standards.

THE *Electro Alloys* COMPANY
Elyria, Ohio

Plants and Slants

The award of the Army-Navy "E" is often the highest recognition and honor in the history of a company. And rightly so! There is usually a set pattern for the celebration—Army or Navy men as speakers, a brass band, preferably the company's own, and a booklet with photos, to commemorate the event.

Occasionally there are welcome variations. The award that went to *Rustless Iron & Steel Corp.*, Baltimore, focused attention on the company's steel process, which enables use of a sub-metallurgical grade chromite in making stainless steel. It saves both chromium and nickel. Moreover, its methods are favorable to the use of American chrome ore.

Off the beaten path, also, was the Red Bank, N. J. plant of the *Bendix Radio Div., Bendix Aviation Corp.*, which limited its ceremony to eight minutes between the day and night shifts.

Over 8,000 men are building one of the nation's largest steel plants near Provo, Utah, costing $150,000,000. *Columbia Steel Co.*, subsidiary of U. S. Steel, is constructing the giant plant for *Defense Plant Corp.* It is scheduled to produce pig iron in April, steel in May, while plates and structurals will appear in June.

About 3,500 tons of steel was conserved by the *American Bridge Co.* in developing the new Navy yard on the Ohio River, which is building landing ships for tanks. The saved steel was material obtained through dismantling inoperative U. S. Steel properties in other localities. It was altered and re-erected. Also, thousands of feet of building enclosure, such as roofing, siding and sash, were likewise reclaimed. One of the re-made buildings has 5½ acres under one roof.

A $26,000,000 addition to the steel plant facilities being built at Fontana, Cal., by the *Kaiser Co., Inc.*, to be completed ten months hence, will add 225,000 tons of steel ingots, or 158,000 tons of finished products, to the plant's capacity. Facilities already under construction, due to be finished in the second quarter, will have a capacity of 450,000 tons of ingots or 300,000 tons of steel plates.

Bausch & Lomb Optical Co., Rochester, is saving 360,000 lbs. of virgin aluminum yearly in castings by the substitution of secondary aluminum. On one contract 25,000 lbs. of virgin aluminum was saved by zinc in aviators' goggle lenses. By shifting from virgin to secondary copper in bronze, 440,000 lbs. of virgin copper was saved. Copper-weld wire has substituted for nickel silver; pig iron was saved by increasing scrap content from 30 to 40 per cent; tin content in bronze was reduced from 8 to 4 per cent; percentage of tungsten in high speed steel was reduced. Nickel and chrome plating have often given way to silver plating and lacquering. Wood, glass and fibre have been used for racks, files and cabinets.

B. F. Sturtevant Co., Boston, has opened a new branch plant at La Salle, Ill.

Aircraft Parts Development Corp., Summit, N. J. has been formed to handle research and development work on parts and materials for the aircraft industry, especially in the fields of fastening devices, powdered metals and plastics.

Independent Pneumatic Tool Co. announces two new addresses in the following cities: 78 Brookline Ave., Boston, and 1411 North Third Ave., Birmingham.

The fifth plant addition since 1931 is announced by the *Osborn Mfg. Co.*, 5401 Hamilton Ave., Cleveland.

Grobet File Co. of America has moved to larger quarters at 421 Canal St., New York.

United Precision Products Co. is now at its new address at 3524 W. Belmont Ave., Chicago.

● Designed to expedite the training of new workers in the use, care and handling of carbide tools, *Carboloy Co., Inc.*, Detroit, offers for general distribution six educational 35-mm. silent slide films.

A complete Bearing Service for the

PRODUCTION FRONT

Idle machinery will not win the war. Most delays, caused by bearing failure, can be avoided. Down time *can* be cut to a minimum. Here's how—

Institute a regular method of inspection . . . once a day for machinery in constant use . . . at least once a week for all others. Make sure the bearings are kept clean, well lubricated and properly aligned.

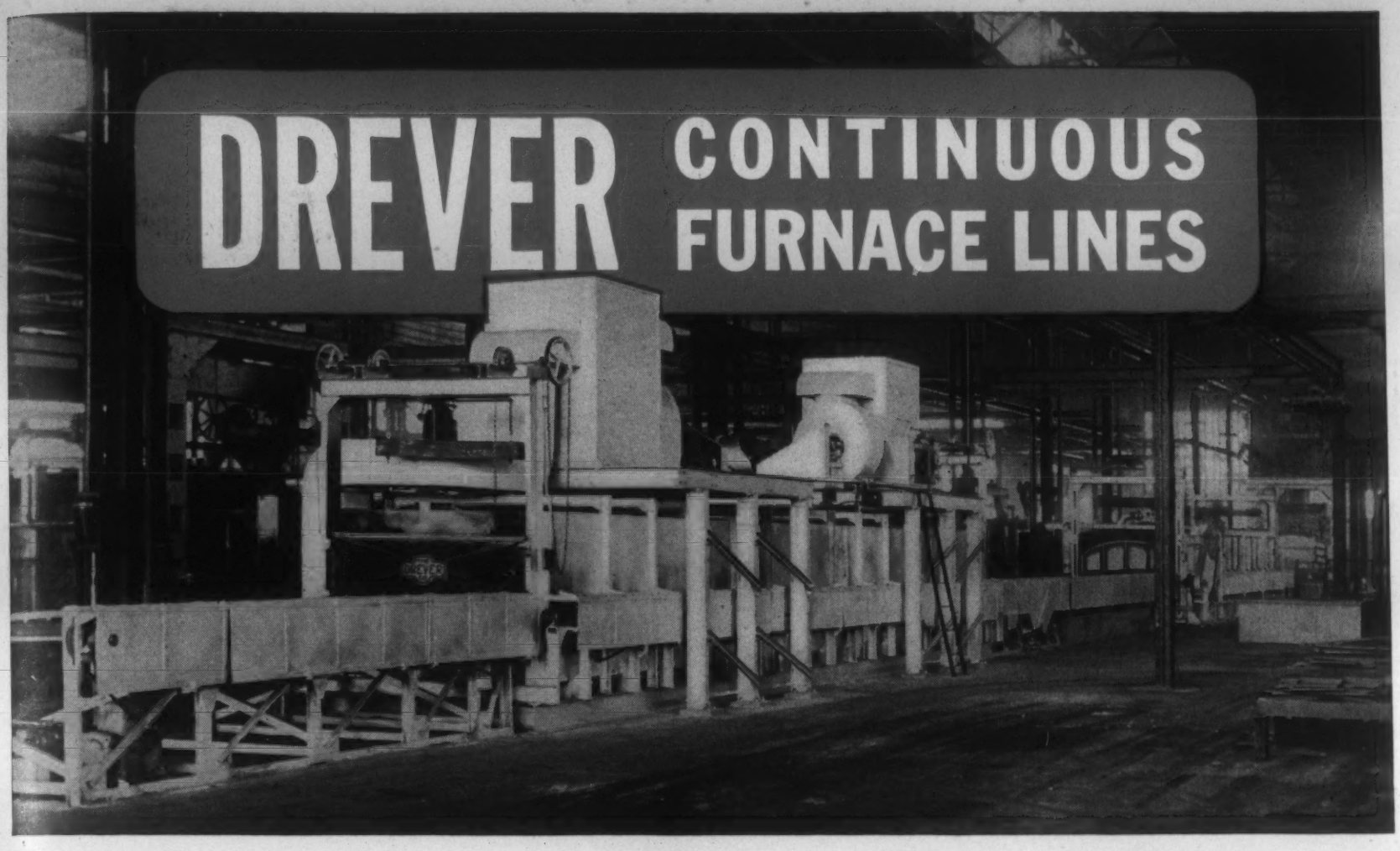
When failure is inevitable, order replacement bearings *in advance*. Call in your local Johnson Distributor. From our list of stock items . . . over 850 sizes of General Purpose Bronze Bearings, 250 types of Electric Motor Bearings, 350 sizes of Johnson UNIVERSAL Bronze Bars . . . he can show you how to secure your needs with a minimum of delay. He is listed in the classified section of your telephone book . . . under BRONZE. Keep every machine going on the Production Front.

● *Write for* FREE *Catalogue* ●

JOHNSON BRONZE

Sleeve BEARING HEADQUARTERS

769 S. MILL STREET • NEW CASTLE, PA.



THE DREVER WAY

THE USUAL WAY

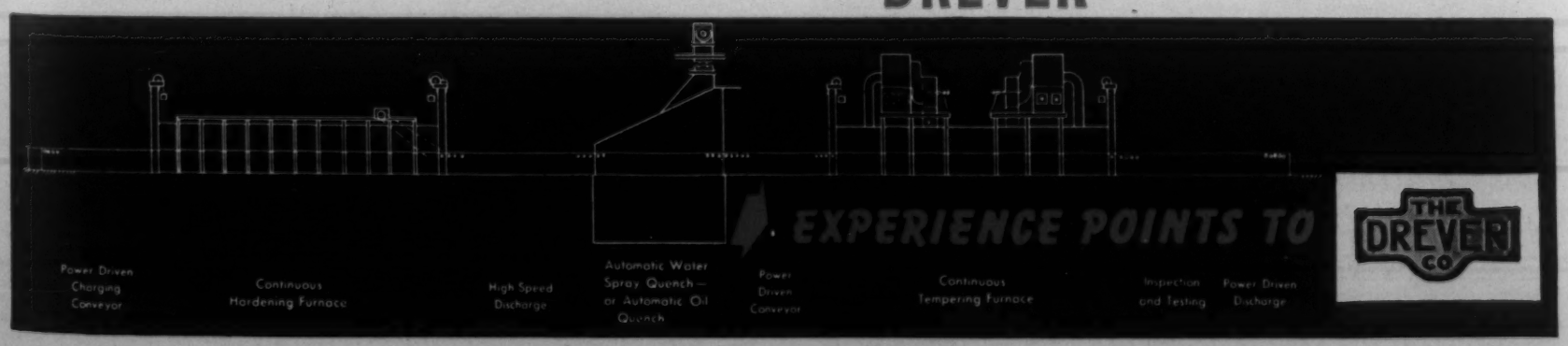
Drever Continuous Furnace Lines are being used by an increasing number of America's leading industries for high quality heat treatment of a wide variety of materials.

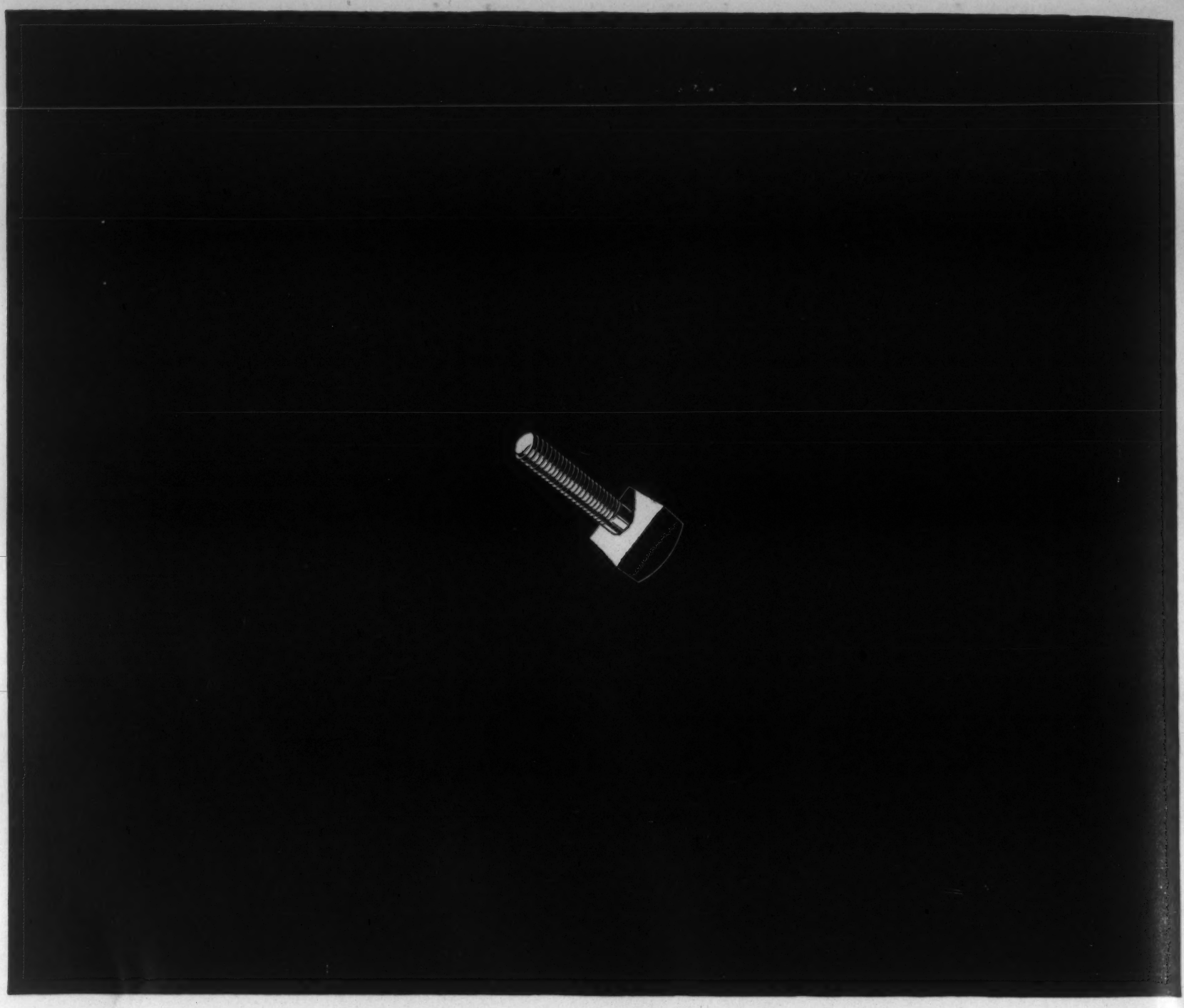
Further information on request.

THE USUAL WAY of putting materials through heat treating operations involves the use of batch type equipment, requiring much manual handling over large transfer areas, resulting in a low production rate at high labor cost.

THE DREVER WAY of continuously handling material through all heat treating operations eliminates intermediate handling, conserves plant space and treats each piece identically. The result is high production of quality material at low labor cost.

THE **DREVER** CO., 750 E. VENANGO ST., PHILA., PA.





Victory could depend on this one bolt!

The failure of a bolt, a rivet or other small part can conceivably spell the difference between victory or defeat.

Guns which operate with precision gears depend for their accuracy on the quality of the metal in their parts. So do bombs and torpedoes.

No tank, plane, gun, ship or bomb can be stronger than its weakest part. That's why parts for weapons are so important. And that's why precision heat-treating plays so large a part in war production—why Gas is so widely used industrially today.

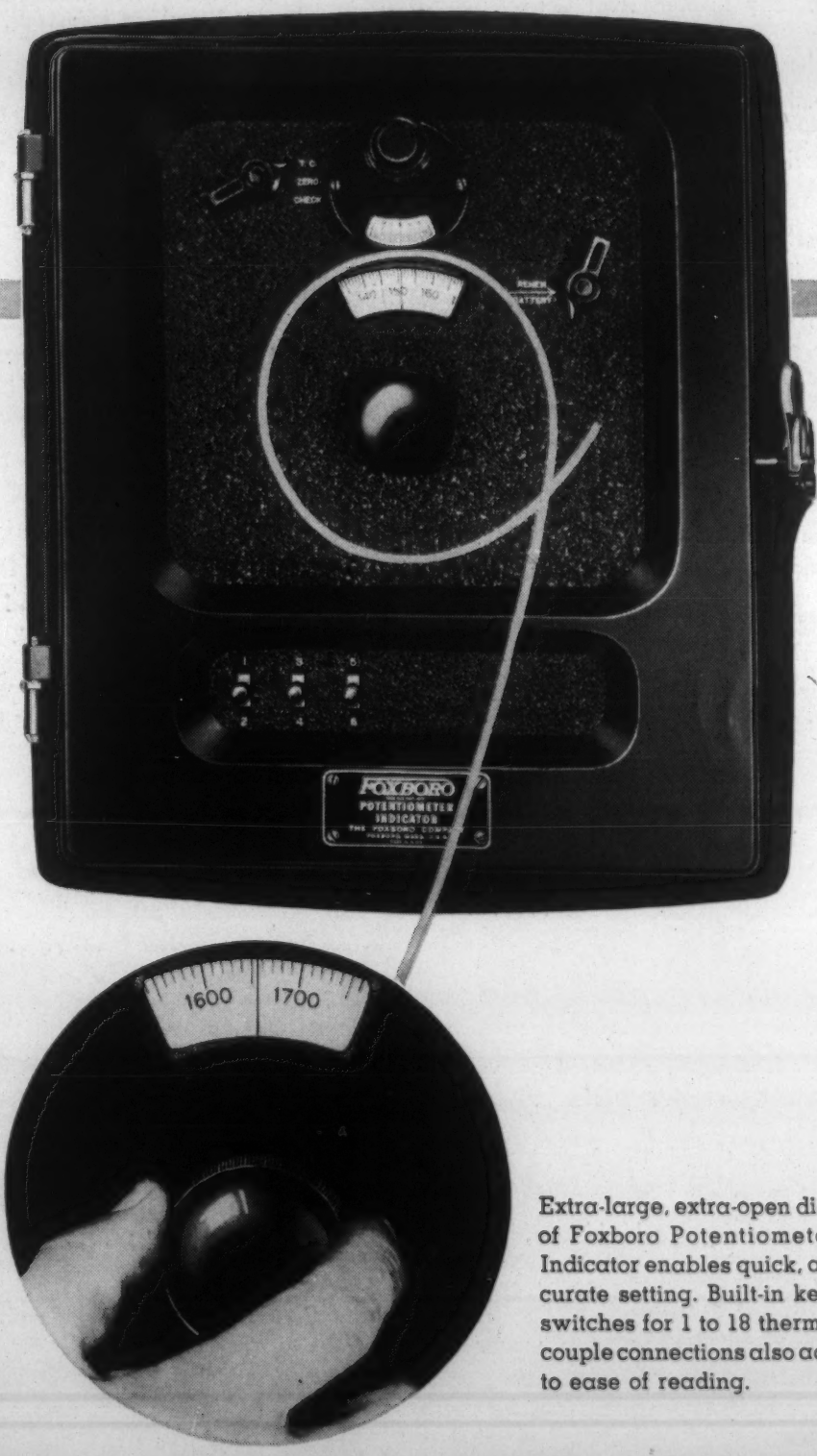
Today, at the shoulder of all war industry, stands the industrial Gas engineer, helping to get the most from this fine fuel. You are welcome to his services—if you need them. Call your Gas company today.

AMERICAN GAS ASSOCIATION
INDUSTRIAL AND COMMERCIAL GAS SECTION
420 LEXINGTON AVENUE, NEW YORK

THE TREND IS TO GAS
FOR ALL INDUSTRIAL HEATING

On-the-Job Precision that approaches Laboratory Standards!

AN INDICATING PYROMETER THAT GIVES UNUSUAL ACCURACY IN THE PLANT



Here's a practical solution to wartime production problems of getting high-accuracy temperature information under today's speeded-up shop conditions!

Foxboro Potentiometer Indicators combine thermal precision approaching laboratory standards, with simplicity of operation that practically eliminates chances of inaccurate setting or reading by operators. Every detail is specially designed for ease and accuracy!

For example, the patented Foxboro Auto-Vernier Rheostat incorporates coarse and fine adjustment slide-wires in a single unit for standardizing the measuring circuit with precision. The extra-large dial provides an open, 17 inch temperature scale which can be easily read to very small units. Further, the vernier setting knob permits precision setting of the measuring slide wire.

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trends

By Edwin F. Cone, Editor

Changes in Steel Consumption

Many changes in the shipments of finished steel to certain industries are taking place as a result of the war. Among those cited by the American Iron and Steel Institute are the following:

In 1941 public construction projects and highway construction, which together took 2 per cent of all steel consumed, are now taking only about 0.6 per cent of that total.

Last year makers of metal furniture, office and household equipment and hardware, consumed about 4 per cent of the total. Now only about 0.7 per cent is going into such needs.

The "Magal Age"

The coining of unusual phrases goes on apace. We recently ran across one that had not come to our attention earlier — the "Magal Age" — though it was suggested several years ago. It refers to magnesium and aluminum and is intended to characterize the emergence of the "Iron Age" into the period when the light metals will predominate and industry will "shake off excess weight from the things it produces."

Saving Aluminum

Aluminum is being conserved in the manufacture of reflectors by substituting silver for it. The General Electric Co. by the use of silvered-glass reflectors in place of aluminum reflectors, reports that it has saved 360,000 lbs.

Molybdenum

Eighty-five per cent of the world's supply of molybdenum is produced here, says a WPB news statement. The domestic supply will increase about 15 per cent in 1943.

Tin Cans

Receipts of prepared tin cans by detinning plants are increasing each month. For July the total was 2,000 tons, for August 4,000 tons, and for September about 8,000 tons. The September shipments have been augmented by the flow of cans from Army camps and from the Navy. One detinning company reported the receipt of 41 carloads from Army camps. This movement also helps the steel scrap supply because 99 per cent of the tin plate is steel plate, recovered after the tin is removed.

Feather-weight Helmets

Plastic helmets, weighing less than 12 oz., are being made by the Westinghouse Electric & Mfg. Co. for our soldiers. They are tough enough to withstand a force of 15 ft.-lbs., which is the same as a pound weight dropped 15 ft. During combat these light helmets are worn as a liner inside a 2-lb. steel helmet. During non-combat service, only the light-weight liner or helmet is worn.

New Records in Wire Output

Production of certain items on a capacity basis by the American Steel and Wire Co. is higher than ever before in the company's history, said C. F. Hood, president of the company in a recent address. Production records are being set every month and up to the end of September, 635 old production marks had been broken since Pearl Harbor. These refer mainly to barbed wire, plain wire and related materials, practically all of it for war use.

Expansion of Industry

Industrialization in the southwestern part of the country is being advanced by the war program to such an extent that many of the plants are making war products for which there has long been a need. Among these is the possible production of electrolytic manganese as soon as power is available.

Not Enough Engineers

"Last year industry asked for four times as many young engineers as the universities and technical schools could provide. This year the need will be greater and next year it promises to be greater still."

Welding Electrodes

The current year's estimated output of welding electrodes, which are consuming an ever increasing amount of steel, is almost four times what it was in 1939, according to the president of the American Steel & Wire Co. in a recent address.

Another Institute

The Powdered Metals Institute with headquarters in Saginaw, Mich., was recently formed by 12 companies which make products from metal powders.

(Additional "Trends" on page 1206)

THE PRODUCTS OF POWDER METALLURGY

BEGIN WITH *METAL POWDERS*

Patterson

GRINDING EQUIPMENT

GIVES YOU

CONTROL

. . . OF POWDER PARTICLE SIZE AND CHARACTERISTIC:

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President

THE PATTERSON FOUNDRY & MACHINE CO.

EAST LIVERPOOL, OHIO, U. S. A.

trends

By Edwin F. Cone, Editor

One Cause of the Scrap Scarcity

A very good explanation of the present trend toward a scarcity of steel scrap has been called to our attention by the American Iron and Steel Institute:

One hundred tons of steel ingots will produce 82 tons of a "heavy" product like structural shapes, but only 65 tons of a "light" product such as cold-rolled sheet or strip steel.

Therefore, when a steel mill rolls 100 tons of ingots into cold-rolled sheets, it produces at the same time 35 tons of scrap suitable for remelting. When the mill rolls 100 tons of ingots into structural shapes it gets back only 18 tons of scrap.

Production has tended decidedly toward the heavy products and hence less scrap has been accumulated.

Plastic Safety Razors

An excellent example of the replacement of a metal by plastics is the average safety razor. A news statement is to the effect that the average metal razor weighs 2 oz. but the new plastic one only ¾ oz. It requires 125 lbs. of brass, steel and zinc to make 1,000 metal razors but only 5 lbs. to produce 1,000 plastic razors. A small metal screw accounts for the 5 lbs. Since 12,000,000 metal razors are normally produced each year, it follows that 1,500,000 lbs. of metal could be saved by replacing all metal razors with the plastic.

Ferromanganese from Low-Grade Ores

Progress is being made in treating low-grade manganese ores so as to make them available for conversion into ferromanganese, according to a recent report of the Bureau of Mines. "These low-grade ores, smelted with either iron or copper sulphides and the resulting matter refined and sintered to a 60 per cent Mn product, have yielded a manganese that meets all specifications of ferroalloy furnace feed."

Scrap Metal Recovery

The recovery of scrap is gaining in momentum and volume. Many large and small companies are active in this drive and have established salvage departments. For example — the General Electric Co. is recovering scrap metals at a rate of 1,000,000 lbs. per day, according to H. J. Beattie, head of the company's salvage department. "An average of 14 carloads of salvaged metal are shipped to mills, foundries and smelters every day in the year." Approximately 20 per cent of the company's salvaged materials are reused as raw materials in the company's operations — scrap steel for steel castings, cast iron for the cupolas, and copper, etc. for crucible melting in the nonferrous alloy foundries.

Shipbuilding Consumes Most Steel

There has been a decided swing in the amount of steel consumed by certain industries as a result of the war. In 1940 the automobile industry, for years the leading steel-consuming industry, took about 16 per cent of the year's output, according to the American Iron and Steel Institute. Now, shipbuilding is consuming a far larger proportion than the automobile took in 1940 — almost 1 out of every 5 tons of finished steel. In 1941 about 10 per cent of the total steel output went to the automotive industry and about 4.5 per cent to shipbuilding.

Steel Salesmen as Scrap Hunters

Many steel and other companies are put to it to find adequate and suitable work for its salesmen. According to the American Iron and Steel Institute, more than 2,000 salesmen employed by steel companies, most of them technically trained and all of them thoroughly familiar with industrial operations, will be engaged in a tremendous treasure hunt for scrap iron and steel during the next few months. This "loan" of 2,000 or more salesmen to the scrap drive is pointed to as the second major contribution by steel companies to the salvage program. The first was the expenditure of $1,500,000 toward financing the nationwide scrap advertising campaign this summer.

Palladium for Platinum

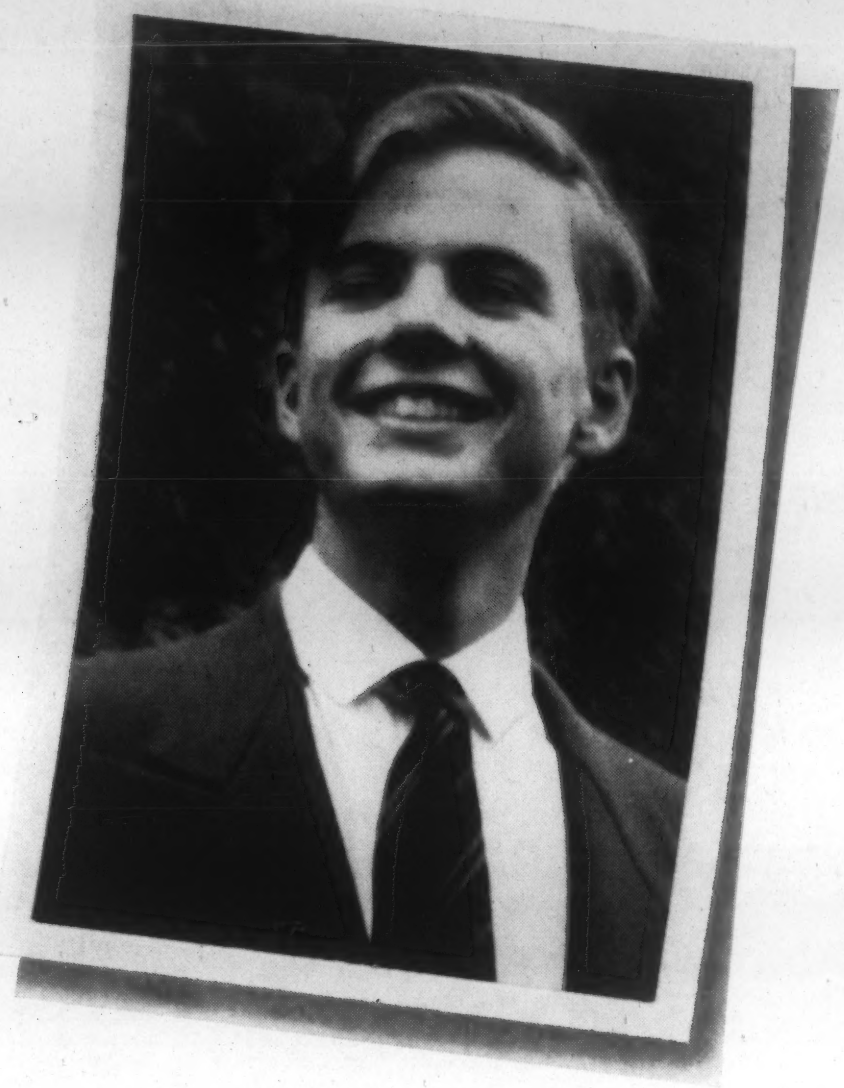
Wartime restrictions on the use of platinum in jewelry has brought about the substitution of gold and palladium. Sufficient palladium is reported by Charles Engelhard of Baker & Co., Newark, N. J., as available to furnish the jewelry trade with a satisfactory alternate for platinum. Palladium and its alloys are said to be readily workable in all operations, the finished jewelry having a lasting brilliance without tarnish.

Demand for Iron Ore

Demands of the war for iron ore show no abatement. This is reflected in the shipments this year by the Great Lakes iron ore fleet. The all-time record of last season of about 81,000,000 tons of ore has already (October) been exceeded and the indications are that the total for the present season will approximate 92,000,000 tons.

(Additional "Trends" on page 1204)

Son...



HE has just turned eighteen. Shaves twice a week and maybe a hair or two is sprouting on his chest. He shies away now when his dad tries to be affectionate and we noticed some lipstick on one of his handkerchiefs after a country club junior dance not so long ago. But it seems only yesterday, perhaps it was the day before, that he was a chubby legged kid swinging from the arch of the doorway, leading to the dining room, in a gadget that was something like a breeches buoy and he was sucking at the end of a turkey bone.

He went back to school this Fall, a tall, athletic lad, budding into manhood, but there was something else on his mind beside the football and hockey teams or the little blonde girl with whom he had "palled" around during the Summer. It seems as though he was listening for a certain call—the Clarion call that poets sing about—and, perhaps we just imagined it, but we thought we saw an upward jutting of his chin, a certain light in his eyes, and a sort of a rearing-to-go expression in his face.

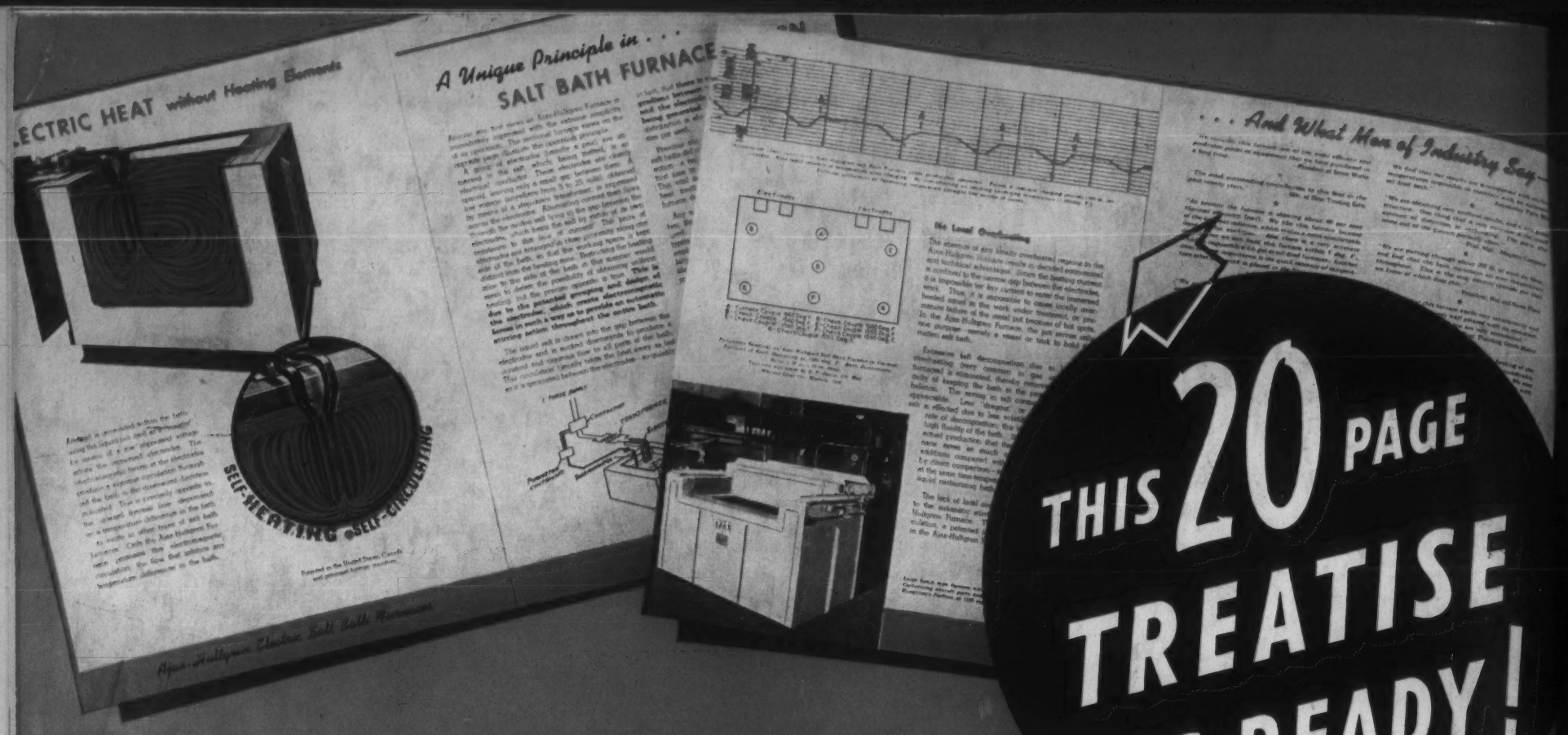
It chilled us a bit in the region of our heart, when we thought of his discarding the sports coat for the "O.D." of the Army or the blue of the Navy. There was a bit of a catch in our throat as we thought of his putting aside his football helmet for one of steel; of his hanging up his hockey stick and reaching for a gun. After all we still regard him as just a little boy.

They tell us that the eighteen and nineteen year old lads are to be called to the service. When that day comes to us there will be prayers, but no tears. We shall not mourn nor shall we be fearful. Rather there will come welling up from our hearts that warm feeling of pride that millions of other parents will sense when their beloved lads marched away. Our lad is no different than the others. We are no different than other loving parents, nor is our sacrifice any greater. They are going to make great soldiers, sailors, marines and fliers out of these youngsters. And they will become a mighty force when they take their places beside their brothers in arms. They too know what they fight for. They too know full well of the sacrifices that must be made before the evil powers that threaten the world can be overcome.

And let us not forget that they are counting on us. They know that we shall not fail them.

God be with them and their brothers.

THE CARBORUNDUM COMPANY, NIAGARA FALLS, N. Y.
REG. U. S. PAT. OFF.



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SUBJECTS COVERED

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BRAZING
BRAZING AND CARBURIZING SIMULTANEOUSLY
CARBURIZING
CYANIDE HARDENING
DRAWING STEEL PARTS
HARDENING HIGH SPEED STEEL TOOLS
HEATING FOR FORGING
NEUTRAL HARDENING
SELECTIVE HEATING
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and

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AJAX ELECTROTHERMIC CORPORATION, *Ajax-Northrup Induction Furnaces for Melting, Heat-Treating*